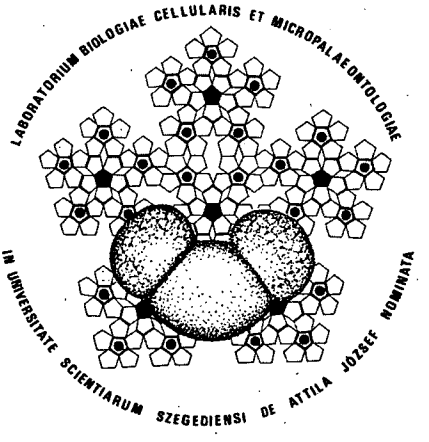
PLANT CELL BIOLOGY AND DEVELOPMENT 13

Plant Cell Biology and Development 13

Financial support

by the Grant OTKA T/9 02308 and T 31715
by the University of Szeged
by the Regional Committee of the Hungarian Academy of Sciences, Szeged



This volume is scientific exchange matter and not commercial

HU ISSN 0866-5443

2001
Szeged

Contents

Contributors

Jayasri BANERJI
Birbal Sahni Institute of Paleobotany, Lucknow, Uttar Pradesh, India,
Andrea BORBOLA
Cell Biological and Evolutionary Micropaleontological Laboratory. University Student.
Andrea HORVÁTH
Cell Biological and Evolutionary Micropaleontological Laboratory. Grammar-school Student.
Eszter HORVÁTH
Cell Biological and Evolutionary Micropaleontological Laboratory. Grammar-school Student.
Miklós KEDVES
Cell Biological and Evolutionary Micropaleontological Laboratory. Honorary Professor.
Madhav KUMAR
Birbal Sahni Institute of Palaeobotany, Lucknow, Uttar Pradesh, India. Scientist 'C'.
Magdolna MADARÁSZ
Cell Biological and Evolutionary Micropaleontological Laboratory. Laboratory Assistant.
Árpád PÁRDUTZ
Institute of Biophysics, Biological Research Center of the Hungarian Academy of Sciences. Research Councillor, Honorary Professor.
Katalin PRISKIN
Cell Biological and Evolutionary Micropaleontological Laboratory. Grammar-school Student.
Judit SASHALMI
Cell Biological and Evolutionary Micropaleontological Laboratory. Grammar-school Student.
Shyam C. SRIVASTAVA
Birbal Sahni Institute of Palaeobotany, Lucknow, Uttar Pradesh, India, Associated Director.
Anita SZÉCSÉNYI
Cell Biological and Evolutionary Micropaleontological Laboratory. Grammar-school Student.
Andrea HORVÁTH
Cell Biological and Evolutionary Micropaleontological Laboratory. Grammar-school Student.
Zsuzsanna TERBE
Cell Biological and Evolutionary Micropaleontological Laboratory. Grammar-school Student.
Surya Kant Mani TRIPATHI
Birbal Sahni Institute of Palaeobotany, Lucknow, Uttar Pradesh, India. Scientist 'D'.

Preface

The new Millennium started, and our Laboratory is still alive and hope that will not be disappeared in spite of the several disadvantageous situations, which emerged several times during the last years.

The "Millennium Medal of the Laboratory" was founded for the 10th Anniversary of the Laboratory which coincide with the Hungarian Millennium. Two silver and altogether 14 copper alloy medal will be distributed.

In recognition of their very high standard scientific achievements, which have influenced in a great measure the research and the special teaching programs of the Laboratory, this year Mme. M. VAN CAMPO (France) and W. KRUTZSCH (Germany) were awarded with the silver medal.

The copper medal was adjudicate to the members of the Editorial Board of the Laboratory namely to: C. ALVAREZ RAMIS (Spain), A. CADMAN (South Africa), T.-C. HUANG (Taiwan), M.A. MORBELLI (Argentina), T. N. TAYLOR (U.S.A.). Moreover E. A. STANLEY (U.S.A.) for a longstanding scientific contact and cooperation S. C. SRIVASTAVA (India) in recognition to the establishment of the new scientific contacts with the Birbal Sahni Institute (Lucknow, Uttar Pradesh, India) and the C.B.E.M. Laboratory (Szeged, Hungary) were also awarded.

As a tradition an exclusive reception was organized in the Laboratory on the 21th August.

The publication of this number was possible by the generous financial support of several institutions and persons. I would like express my sincerest thanks,

to the Grant OTKA T/9 02308 and T 031715,

to the University of Szeged,

to the Regional Committee of the Hungarian Academy of Sciences, Szeged,

to Prof. Dr. K. BURGER (deceased recently) and Prof. Dr. K. TANDORI members of the Hungarian Academy of Sciences,

to Prof. Dr. R. MÉSZÁROS, Rector of the University of Szeged.

Szeged, 30. December, 2000.

M. KEDVES
Head of the Laboratory

1. TO THE TENTH ANNIVERSARY OF THE CELL BIOLOGICAL AND EVOLUTIONARY MICROPALEONTOLOGICAL LABORATORY

M. KEDVES and M. MADARÁSZ

Cell Biological and Evolutionary Micropaleontological Laboratory of the University of Szeged, H-6701, P.O. Box 993, Szeged, Hungary

It has been ten years ago, that Prof. Dr. B. CSÁKÁNY as the Rector of the University agreed the statutes of the Laboratory which regulate in detail the place and the function of our scientific and teaching unit. There were several different events during the last ten years but the Laboratory is in function which was affirmated on the 12. 12. 1995 by an agreement by Prof. Dr. R. MÉSZÁROS, Rector of the University. In the last years several untruthful informations were disseminated by E-mail by some persons concerning the status and the scientific cooperation of the Laboratory. In two numbers (9., 12.) of Plant Cell Biology and Development the refutation was short published of these gossips.

The principle of the scientific and educational program of the Laboratory is the multidisciplinarity and the quick acceptance of the new directions in methods and concepts from different disciplines. It is a hope that this was essentially succesful. An important task of this period was to solve the generation problems. This was also succesful, because always a remarkable number of middle school student are working in the Laboratory giving up a great part of their leasure time. The longstanding cooperation with the EM Laboratory of the Department of Biophysics of the Biological Research Center of the Hungarian Academy of Sciences assured on a high level the ultrastructure researches of the research programs of the Laboratory. In person the joint research programs with Prof. Dr. Á. PÁRDUTZ are extremely fruitful in every respect. Outside the Laboratory the international connects and cooperations are in the first place. The intensive joint research programs with the Birbal Sahni Institute (Lucknow, India), and the Department of Paleontology of the University Complutense of Madrid (Spain) may be emphasized. But the cooperation with the colleagues of Ljubljana (Slovenia), and with the Ain Shams University of Cairo (Egypt), and as new contact the University of San Salvador (El Salvador) were realized during the last times. In retrospect to the last decade we can point out the following:

From the youngest generation of the Laboratory the following middle school students took part in the realization of the research programs: AILER, P., BELLON, A., BENN, O., BORBOLA, A., BORSODI, A., DOBÓ, K., FARKAS, E., GAUDÉNYI, SZ., GUBÁS, T., HEGEDŰS, A., HORVÁTH, A., HORVÁTH, ERIKA, HORVÁTH, ESZTER, KALMÁR, Á., KANCSÁR, T., KOVÁCS, E., MÉSZÁROS, E., MÉSZÁROS, K., MÉSZÁROS, R., OLÁH, I., RONTÓ, G., SASHALMI, J., SCHMÉL, Á., SZÉCSÉNYI, A., SZLÁVIK, N., TERBE, ZS., TOMBÁCZ, D. and TÓTH, A. During this year PRISKIN, K. started the work in our Laboratory. Among them TÓTH, A., FARKAS, E., BORBOLA, A. and HORVÁTH, ERIKA contin-

ued the work in the Laboratory as university students. After her diploma TÓTH, A. became the member of the Laboratory and BORBOLA, A. is working among orders on diploma thesis. The following university students contributed to the realisation of the research programs: GÁSPÁR, I., GOTTL, E., KEDVES, L., UNGVÁRI, E., VARGA, A. and VÉR, A. Diploma theses were made by GÁSPÁR, I., KEDVES, L. and VÉR, A. PhD Students working on joint research programs with the Laboratory: GULYÁS, S., KOVÁCS, G. The assistants of the Laboratory changed very often because of the low salary. During the last period the following person contributed to the results of the Laboratory: BÍRÓ-HALÁSZ, I., ERDŐDI, Á., KÁROSSY, Á., KECSKEMÉTI, V., MARKÓ, E., MÁRAMAROSI, É., PAPP-NAGY, É., PAPP, ZS. and PÖLÖS, K.

Very fruitful scientific cooperations were carried out with the following scientists: HABLY, L. D. Acad. Sci., HETÉNYI, M. D. Acad. Sci., MONOSTORI, M. D. Acad. Sci., PÁRDUTZ, Á. D. Acad. Sci., SAJGÓ, Cs. C. Geol. Sci., SZEDERKÉNYI, T. D. Acad. Sci., BAGI, I. C. Biol. Sci., ROJIK, I. C. Biol. Sci., SZÓNOKY, M. C. Geol. Sci., KINCSEK, I. PhD., SIEGL-FARKAS, Á.

The following colleagues from different countries contributed with different kind of papers to the scientific achievements of the Laboratory: ALMENDROS, G. (Spain), ALVAREZ RAMIS, C. (Spain), ANICIC, B. (Slovenia), BARATTOLO, F. (Italy), BREZIGAR, A. (Slovenia), BUSER, S. (Slovenia), CAFFAU, M. (Italy), CIMERMAN, F. (Slovenia), CLEMENTE BELMONTE, P. (Spain), DEJAX, J. (France), DROBNE, K. (Slovenia), EL-SAADAWI, W. E. (Egypt), FERNANDEZ MARRÓN, M. T. (Spain), GALVANI, R. (Italy), GÓMEZ PORTER, P. (Spain), HERNGREEN, G. F. W. (The Netherlands), JELEN, B. (Slovenia), KRUTZSCH, W. (Germany), KUMAR, M. (India), KUMAR, P. (India), KVAVADZE, E. V. (Georgia), LAAMARTI, N. (Morocco-Spain), LAGOS, J. A. (Spain), MARTIN-ALGARRA, A. (Spain), MONTENEGRO, M. E. (Italy), MOSTAFA, R. M. (Egypt), PAVLOVEC, R. (Slovenia), PAVŠIČ, J. (Slovenia), PIRINI-RADRIZZANI, N. (Italy), PLENIČAR, M. (Slovenia), PUGLIESE, N. (Italy), ROVNINA, L. (Russia), SALARD-CHEBOLDAEFF, M. (France), SKABERNE, D. (Slovenia), SOLÉ DE PORTA, N. (Spain), SMIRNOVA, S. B. (Russia), SRIVASTAVA, S. C. (India), TRIPATHI, S. K. M. (India), TURNŠEK, D. (Slovenia), VEGAS, J. (Spain), YOUSSEF, S. G. M. (Egypt).

Visiting scientists during the last 10 years: **1991**: FERNANDEZ MARRÓN, M. T. (Spain), JELEN, B. (Slovenia), **1992**: FERNANDEZ MARRÓN, M. T. (Spain), DUJMOVIC-KRIZMANIC, K. and KRIZMANIC, K. (Croatia), SRIVASTAVA, S. C. (India), **1993**: JELEN, B. (Slovenia), ALVAREZ RAMIS, C. (Spain), **1994**: CERCEAU, D. (France), JELEN, B. (Slovenia), **1995**: PHILIPPE, M. (France), ALVAREZ RAMIS, C. (Spain), SRIVASTAVA, A. K. (India) **1996**: TRIPATHI, S. K. M. (India), **1997**: YAVUZ, N. (Turkey), SRIVASTAVA, S. C. (India), MARC, P. (France), KUMAR, M. (India), **1998**: ALVAREZ RAMIS, C. (Spain), JUEZ, G. (Chile), STANLEY, E. A. and STANLEY, A. (U.S.A.), **2000**: ALVAREZ RAMIS, C. (Spain).

To the 5th Anniversary of the official recognition of the Laboratory a "Commemorative Medal of the Laboratory" and the "Diploma of the Laboratory" was founded. The following persons were awarded with the above mentioned medal:

1995: Prof. Dr. CSÁKÁNY, B. (Hungary), Mme. VAN CAMPO, M. (France), Prof. Dr. KRUTZSCH, W. (Germany), **1996**: Prof. Dr. PÁRDUTZ, Á. (Hungary), Prof. Dr. ALVAREZ RAMIS, C. (Spain), Prof. Dr. SOLÉ DE PORTA, N. (Spain), **1997**: Prof. Dr. SZEDERKÉNYI, T. (Hungary), Dr. SRIVASTAVA, S. C. (India), Dr. VENKATACHALA, B. S. (India), **1998**: Prof. Dr. NAGY, ESZTER (Hungary), Prof. DR. EL-SAADAWI, W. (Egypt), Prof. DR. STANLEY, E. A. (U.S.A.), **1999**: Prof. Dr. NILSSON, S. (Sweden), Dr. ROWLEY, J. R. (Sweden), Dr. TRIPATHI, S. K. M. (India).

The Laboratory Diplomas were distributed for the following persons: 1995: Dr. KINCSEK, I. (Hungary). TÓTH, A. (Hungary), Dr. I. BAGI (Hungary), 1996: VÉR, A. (Hungary), TRIPATHI, S.K.M. (India), 1997: BORBOLA, A. (Hungary), 1999: Dr. MADHAV KUMAR (India).

To the Tenth Anniversary and the Hungarian Millennium, as it was mentioned previously the "Millennium Medal of the Laboratory" was founded. The two silver medal was offered to Mme. M. VAN CAMPO (France) and to W. KRUTZSCH (Germany). From the 14 copper medal seven was distributed at this occasion, to: C. ALVAREZ RAMIS (Spain), A. CADMAN (South Africa), T.-C. HUANG (Taiwan), M. A. MORBELLI (Argentina), S. C. SRIVASTAVA (India), E. A. STANLEY (U.S.A.), T. N. TAYLOR (U.S.A.).

Probably it was a remarkable result, during this period that it was succesful to get the financial support for the printing and the distribution cost of the Laboratory. 12 number of Plant Cell Biology and Development appeared with 100 papers, and with the contribution the following auctors: AILER, P., ALMENDROS, G., ALVAREZ RAMIS, C., BAGI, I., BENN, O., BORBOLA, A., BORSODI, A., BREZIGAR, A., BUSER, S., CIMERMAN, F., DEJAX, J., DOBÓ, K., DROBNE, K., EL-SAADAWI, W. E., FARKAS, E., FERNANDEZ MARRÓN, M. T., GAUDÉNYI, SZ., GÁSPÁR, I., GOTTL, E., GUBÁS, T., GULYÁS, S., HABLY, L., HEGEDŰS, A., HORVÁTH, A., HORVÁTH, ERIKA, HORVÁTH, ESZTER, JELEN, B., KALMÁR, Á., KANCSÁR, T., KÁROSSY, Á., KECSKEMÉTI, V., KEDVES, L., KEDVES, M., KINCSEK, I., KOVÁCS, E., KOVÁCS, G., KRUTZSCH, W., KUMAR, M., KUMAR, P., KVAVADZE, E. V., LAAMARTI, N., LAGOS, J. A., MADARÁSZ, M., MARTIN-ALGARRA, A., MÉSZÁROS, E., MÉSZÁROS, K., MÉSZÁROS, R., MONOSTORI, M., MOSTAFA, R. M., OLÁH, I., PÁRDUTZ, Á., PAPP-NAGY, É., PAVLOVEC, R., PAVŠIČ, J., ROJIK, I., RONTÓ, G., SALARD-CHEBOLDAEFF, M., SASHALMI, J., SIEGL-FARKAS, Á., SKABERNE, D., SOLÉ DE PORTA, N., SRIVASTAVA, S. C., SZEDERKÉNYI, T., SZÉCSÉNYI, A., SZLÁVIK, N., SZÓNOKY, M., TERBE, ZS., TOMBÁCZ, D., TÓTH, A., TRIPATHI, S. K. M., UNGVÁRI, E., VARGA, A., VÉR, A., VEGAS, J. and YOUSSEF, S. G. M. Monographs were also published: 1994: Transmission electron microscopy of the fossil *gymnosperm* exines, 1995: Upper Cretaceous spores from Egypt, 1996: Transmission electron microscopy of the fossil spores.

Papers were published in the following Hungarian reviews: 1991: Bio-Tár, 1991,1992: Őslénytani Viták, 1991, 1992: Acta. Biol. Szeged., 1992, 1999: Ann. Univ. Sci. Sect. Geol., Budapest,1992, 1999: MTA SZAB, 1999: Bot. közl., 1998: Magyar Őslénytani Vándorgyűlés (Tata).

Publications in the following foreign and international periodicals: 1991, 1994, 1995, 1997, 1999: A. P. L. F. Symposium - Abstracts, 1992, 1994, 1996, 1998: A. P. L. E. Symposium - Abstracts, 1992, 1996: Internat. Palynol. Congr. - Abstracts, 1994, 1995, 1997, 1999: Symp. of African Palynology - Abstracts, 1992, 1996, 1998: Taiwania, 1992: International Workshop on Pyrolysis - Abstracts, 1998: European Palaeobot. and Palynol. Conference - Abstract, 1996: American Association of Stratigr. Palynol. Foundation, 1993: Grana Suppl., 1998: Grana, 1994: 11th Slovenian Geol. Meeting - Abstracts, 1992: I. U. G. S. - S. C. G. - Abstracts, 1993: Int. Bot. Congr. - Abstracts, 1993: Int. Meeting on Organic Geochem., 1995: First Croatian Geol. Congr.,1998: Dela-Opera SAZU, 1998: Pollen and Spores 1998 Morphology and Biology. Int. Conf. - Abstracts, 1996: Revista Española de Micropaleontologia, 1996: Estudios Palinologicos, 1998: Bot. Macaronésica, 1991: Expoloration Geochemistry, 1998: Meded. Nederlands Inst., 1999: 4th Symposium of African Palynology - Abstracts, 1999: XVI. Symp. A.P.L.F. - Abstracts, 1999: VII Symp. on Mesozoic Terrestrial Ecosystems - Abstracts.

Laboratory meetings were organized regularly. In parentheses the name of the students are written after the date of the meeting who contributed to the program

1991 - 01/03 (Vér, A.), 22/03, 12/04, 17/05 (VÉR, A.), 22/11, 29/11; **1992** - 21/02, 06/03, 24/04 (GÁSPÁR, I.), 20/10, 06/11 (VÉR, A.); **1993** - 05/02, 02/04 (GÁSPÁR, I.), 12/11, 22/12; **1994** - 21/02, 26/03, 02/10, 25/11, 09/12 (GÁSPÁR, I.); **1995** - 27/01, 17/02 (GÁSPÁR, I.), 17/03 (GÁSPÁR, I.), 07/04 (GÁSPÁR, I.), 28/04, 18/08, 22/08, 22/09, 13/10; **1996** - 09/02, 01/03, 22/03 (KÁROSSY, Á., BORBOLA, A.), 19/04 (KÁROSSY, Á., BORBOLA, A.), 22/05, 21/08, 29/08, 13/09, 04/10, 08/11, 29/11; **1997** - 14/02, 07/03, 11/04, 21/08, 22/08, 05/09, 26/09, 31/10; **1998** - 20/02, 28/03, 25/04, 13/06, 21/08, 19/09, 10/10, 07/11 (HORVÁTH, Erika); **1999** - 06/02, 13/02, 13/ 03, 27/03, 15/05, 21/08, 04/09, 09/10, 20/11, 18/12; **2000** - 29/01, 26/02, 25/03, 29/04, 27/05 (BORBOLA, A.), 08/07, 26/08, 23/09 (BORBOLA, A.), 21/10, 25/11,

Papers were delivered on the following Hungarian scientific meetings:

1992. - 26-27/03: Symmetry - Asymmetry Conference - Szeged. 18/05: Paleobotany and Environment Contributions - Budapest. 1994. - 09/05: Statutory Meeting of the Symmetry Workshop - Szeged. 1995. - 15/12: Habilitations Lecture at the Department of Paleontology, Eötvös University - Budapest. 1996. - 02/12: 1316th meeting of the Botanical Section of the Hungarian Biological Society - Budapest.

1997. - 05/05: 1322nd meeting of the Botanical Section of the Hungarian Biological Society - Budapest. 19/11: Scientifical Meeting of the Paleontological Commission of the Hungarian Academy of Sciences - Budapest. 15/12: 1329th meeting of the Botanical Section of the Hungarian Biological Society - Budapest. 1998. - 06/04: 1334th meeting of the Botanical Section of the Hungarian Biological Society - Budapest. 07/04: meeting of the Geological Section of the Hungarian Biological Society - Budapest. 08-09/05: 1st Hungarian Paleontological Symposium - Tata. 24/08: Conference of Symmetry and Asymmetry - Szeged. 17/09: Paleontological Commission of the Hungarian Academy of Sciences - Budapest. 30/11: 1341th meeting of the Botanical Section of the Hungarian Biological Society - Budapest. 1999. - 19/04: 1347th meeting of the Botanical Section of the Hungarian Biological Society - Budapest. 29/11: 1353th meeting of the Botanical Section of the Hungarian Biological Society - Budapest.

Contributions on international congresses or conferences and scientific institutions:

1991. - 23-27/09: XII^{e} Symposium A.P.L.F. - Caen, France. 8-22/10: Spain. **1992**. - 9-11/06: Workshop on Pyrolysis in Organic Geochemistry International Workshop - Szeged. 21-24/07: Joint researches - Slovenia. 06-12/09: 8th Internat. Palynol. Congr. - Aix-en-Provence, France. 05-19/10: Joint researches - Madrid, Spain 30/11-04/12: 9° Simposio de Palinologia A.P.L.E. - Las Palmas de Gran Canaria. **1993**. - 20-22/05: Scientific meeting dedicated at the occasion of Prof. Dr. W. Krutzsch's 65th birthday - Berlin, Germany. 27/08-05/09: XVth International Botanical Congress - Yokohama, Japan. 18-26/09: XIIIth Symp. of the A.P.L.F. - Besançon, France. 11-25/10: Joint researches - Madrid, Spain. **1994**. - 01-06/08: Common working with Dr. B. JELEN - Ljubljana. 16-23/09: Xth A.P.L.E. Symp. - Valencia. 24/09: Joint researches - Barcelona. **1995**. - 20-26/01: Joint researches - Lucknow, India. 05-10/03: 2nd Symp. of African Paly. - Tervuren, Belgium. 11-14/03: Joint researches - Barcelona, Spain. 16-19/09: 14^{e} Symp., Association des Palynologues de Langue Française, Palynologie et Changement Globaux - Paris, France. 19-22/10: First Croatian Geological Congr. - Opatija, Croatia. **1996**. - 23-28/06: Ninth International Palynological Congress. - Houston, Texas. 18-20/09: XI Simposio de Palinologia, A.P.L.E. - Alcalá de Henares, Spain. 23-27/09: Joint researches - Madrid, Spain. **1997**. - 26/03-01/04: Joint researches - Barcelona, Spain.

08-10/06: Joint researches Barcelona, Spain. 29/08-03/09: XVème Symp. A.P.L.F. - Lyon, France. 12-21/09: 3rd Symp. of African Palynology - Johannesburg, South-Africa. **1998**. - 27/01-07/02: Visit at the Birbal Sahni Institute of Palaeobotany - Lucknow, India. 08-11/02: Visit at the Indian National Science Academy - New Delhi, India. 25/06-01/07: 5th European Palaeobotanical and Palynological Conference - Krakow, Poland. 04-10/07: Pollen and Spores 1998 Morphology and Biology, The Royal Botanic Gardens - Kew, London, U. K. 26-28/09: Joint researches - Madrid, Spain. 29/09-03/10: XII. Simp. de Palinologia A.P.L.E. - Leon, Spain. **1999**. - 23/02-08/03: Visit at the Birbal Sahni Inst. of Palaeobotany - Lucknow, India. 24/04-02/05: 4th Symp. of African Palynology - Sousse, Tunis. 13-19/09: XVI th Symp. of A.P.L.F. - Liège, Belgium. 26/09-01/10: VII Internat. Symp. on Mesozoic Terrestrial Ecosystems - Buenos Aires, Argentina. **2000**. - 24-30/06: Xth Internat. Palynol. Congress - Nanjing, China.

Teaching programs: Introduction to the pre-Quaternary Palynology I., II. Introduction to the Supernova Theory. Theory of the evolution and its natural phylosophical relations.

Basic palynology. Applied palynology. Ultrastructure of the plant cell wall. Quasi-crystalloid biopolymer systems.

The function of the Laboratory was assured in the first place by grants. The following competitions for grants were succesful: MM (Ministery of Culture) ÁMB (1986-1989), OTKA (National Scientific Research Programs):1/2-88, 1/3-104, 1/5 T007206, 1/7 T 014692, recently T/9 023208 and T 031715, U - 21427, U - 31146, P 31176, B 011106, AKP 98/26.2,5/23 (Foundation of the Hungarian Academy of Sciences). The publications of the Laboratory were supported regularly or occasionally by several personalities and Institutions. Many thanks to: Presidium of the Hungarian Academy of Sciences, to Dr. D. KOSÁRY, President and Dr. I. LÁNG, Secretary General, to Dr. Gy. TELEGDY President and Dr. T. BALOGH Secretary of the Regional Committee of the Hungarian Academy of Sciences, Szeged. To Dr. K. TANDORI, member of the Hungarian Academy of Sciences. To Prof. Dr. B. CSÁKÁNY as Rector of the University, Prof. Dr. J. CSIRIK as Rector of the University, Prof. Dr. R. MÉSZÁROS as Rector of the University. To Prof. Dr. I. DÉKÁNY as Scientifical vice-rector of the University, Prof. Dr. B. RÁCZ as Scientifical vice-rector of the University, Prof. Dr. I. NAGYPÁL as Scientifical vice-rector of the University. To Prof. Dr. R. MÉSZÁROS as Dean of the Faculty of Sciences, Prof. Dr. K. VARGA as Dean of the Faculty of Sciences, Prof. Dr. G. MEZŐSI as Dean of the Faculty of Sciences. To Dr. T. KECSKEMÉTI, president of the Hungarian Geological Society. To Dr. I. SZALAY Major and Dr. I. FARKAS Town-Councillor of the Local Government of Szeged. To the Hungarian Oil and Gas Industrial Company, to Mr. G. JÓZSEF business manager and Mr. Cs. GALÁNFI head of department. To the Foundation for Szeged. To the Foundation for the Science of the South Hungarian Plain. To the CSIC - Instituto de Geologia Economica, Madrid, Spain Projecto PB 92-0101.

The linguistic corrections of the English text were made by Dr. R. ZÁNTHÓ Ass. Prof. of the Dept of the English Language of the J.Gy. High School, we regret that he deceased on the 15.07.2000. We lost a very nice and a very helpful person. Thanks to Dr. Zs. GÉCSEG (Department of the French Institute of J.A. University) for the linguistic corrections of the French manuscript.

The first part of the publications of the Laboratory were published by the Szegedi Nyomda. In 1994 the following monograph "Transmission electron microscopy of the fossil *gymnosperm* exines" was published by the Juhász Nyomda. After this all publications of the Laboratory were published by this printing office. Very fruitful relationships are with this printing office. We are very grateful to Mr. P. JUHÁSZ (head of the printing office) and to Mr. Z. KORPA (co-worker of the printing office) for its excellent work.

2. PENTOXYLON PLANT: A RECONSTRUCTION AND INTERPRETATION

SHYAM C. SRIVASTAVA and JAYASRI BANERJI

Birbal Sahni Institute of Palaeobotany, 53 University Road, Lucknow - 226007, India

Abstract

Considering the constant association of vegetative and fertile organs: *Pentoxylon* (stem), *Nipaniophyllum* (leaf), *Sahnia* (pollen organ) and *Carnoconites* (seed cone), it has been tempting to envisage as to how the whole *Pentoxylon* plant might have looked like by piecing together. Also it is speculated in what kind of possible habitation or surrounding it could have been thrived. However, it seems very likely that this branched shrubby plant could have attained the height of possibly a small tree possessing supposedly a robust crinkled stem devoid of leaf bases probably thrown off with the maturity. Further, the branches presumably have been portrayed arising and dichotomizing at the extremity of stem whereas the branch scars due to shedding are shown at lower level. The dichotomized branches bear long and short shoots. The long shoots demonstrate sparsely placed leaf cushions while the short shoots have closely placed leaf cushions. The foliage and fertile organs are borne on different kinds of short shoots. However, the attachment on short shoots is indicative of these diverse plant organs belonging to the same plant. The woody short shoots having spirally arranged persistent rhomboid leaf base-cushions depict terminally dichotomizing branchlets each bearing broadly conical head. The female cone *Carnoconites* containing spirally arranged seeds possessed their micropyles pointing outwards. The outer fleshy and inner stony layer are well developed and nucellus is free from the integument. The short shoots of thick parenchymatous cells terminate into pollen cone *Sahnia* borne on a collar like structure formed by the raised margin of receptacle. The pollen organ consists of persistent microsporangiophores bearing short branch with several stalked rounded sporangia containing oval monocolpate pollen grains showing longitudinal dehiscence. The slender short shoots which are borne in the axils of long shoots generally bear in apical portion bunch of simple rather stiff, coriaceous, strap-shaped leaves of *Nipaniophyllum*. The plants were deciduous dropping off the leaves in their entirety. Whether the *Pentoxylon* plant was monoecious or dioecious, for the present, it has been taken as to be monoecious because *Sahnia* though very rare has always been found intimately associated with *Carnoconites* which generally occurs detached enormously among other plant remains. Further, the occurrence of *Pentoxylon* plant has been noted in overwhelming majority in the floral assemblage of *Nipania*, Rajmahal Hills, India, wherein the representation of *phycophytes, mycophytes, pteridophytes*, and *cycadophytes* are less frequent. However, the conifers are quite common. The advent of *pentoxylopsids* mark a floral change, thereby confirming the younger age for *Nipania* deposits among the various fossil sites of Rajmahal Hills. Taking the floral composition of *Nipania* as a whole, it appears, that the vegetation flourished along the lake margins on volcanic terrain under subtropical humid climate. Besides, the discovery of *Pentoxylon* plant from Australia, New Zealand and Antarctica is quite significant, keeping in view the free dissemination of plant all over the Gondwana countries until the breakup of this supercontinent.

Key words: Pentoxylon, macrofossil, reconstruction, Gondwana.

Introduction

Our inquisitiveness as to how the *Pentoxylon* plant must have looked like inspired us to propose the reconstruction presented here. The consistent co-occurrence of isolated parts of pentoxylopsids and their structure similarity suggested that they belong to one

and the same plant. Since the association of the plant parts were in sufficient frequency, it has been ventured to piece them together in the form of an entire plant.

The pentoxylopsids come from the locality of Nipania in Rajmahal Hills, Bihar which was first discovered in situ by HOBSON (1928 in PASCOE, 1929). From this collection SAHNI (in PASCOE, 1929) reported for the first time the plant fossil-leaves preserved in cherts in the form of silicified blocks. Further, SAHNI (1932) traced the affinity of these leaves. However, in subsequent years from these white or cream-coloured rocks (weathering rusty brown) at the head of ravine about half a mile east of *Nipania* Village. SAHNI and RAO (1933) made the first collection and enlisted a good many plant fossils. Since then in series of publications (SAHNI 1932, 1935, 1938, 1948; SAHNI and RAO, 1933; RAO 1935, 1936, 1943a,b,c, 1947, 1974; SRIVASTAVA 1935, 1937, 1944, 1946; VISHNU-MITTRE 1952, 1953, 1955, 1958, 1969; SINGH 1957) contributed to the paleofloristics of *Nipania.*

The diverse plant organs represent portions of two species because the seed cone - *Carnoconites* known by two species *C. compactus* and *C. rajmahalensis* WIELAND described by SRIVASTAVA (1944) and BOSE et al. (1985). So as the leaf-genus differentiated on the basis of size is also represented by *Nipaniophyllum raoi* and *N. hobsonii.* However, the stem genus *Pentoxylon* has been known so far only by one species: *P. sahnii.* SHARMA (1969, 1973a,b, 1974, 1975, 1979, 1980, 1996) made a critical observation of branching pattern and anatomy of *Pentoxylon sahnii* inclusive of dwarf shoots. The polymorphic branch system of *Pentoxylon*-plant compose of long shoots (without leaf bases), thin shoots (with sparse leaf bases) and dwarf shoots bearing fertile organs (with closely placed leaf bases). The pollen organ *Sahnia* was first described and discovered by VISHNU-MITTRE (1953) and later BOSE et al. (1985) made comprehensive observations based on several specimens. SUTHER and SHARMA (1988) interpreted differently while reconstructing this pollen organ.

From these various parts it is tempting to envisage a *gymnospermous* plant perhaps not too tall with foliage borne on the stem. In this reference, the first reconstruction was proposed by SAHNI (1948) which substantiated that *Nipaniophyllum raoi* was borne on the female shoot possessing *Carnoconites* besides he also dealt with the systematic position and could visualize that the *Pentoxylon* plant should have been a branched shrub or xerophytic small tree in habit. The inference for xeric nature could be deduced on the basis of deciduous nature of leathery leaves and succulent sarcotesta of the *Carnoconites.* The unisexual flower were borne at the end of lateral dwarf shoots. The young flowers among the terminal branch of simple strap-shaped leaves were protected by scale leaves which were shed by the formation of an abscission layer quite identical to the one formed by foliage. Leaf bases probably were thrown off from the older stem with the formations of bark maturation.

Another reconstruction attempt came into light when ROZEFELDS (1982) contemplated it to be like a medullosan tree an extremely speculative interpretation based upon the specimens discovered from Early Cretaceous of Australia. Later Mary WHITE (1990) reconstructed the *Pentoxylon australica* somewhat similar to a *cycadophytic* plant. Lately SHARMA (1996, text-fig. 1J) presented a reconstruction of *Pentoxylon sahnii*-plant as a small tree with multimorphic branches, polystelic vasculature and diploxylic bundle of *Nipaniophyllum* leaves. However, it was based upon vegetative parts, no fructification could be depicted, henceforth, it would not be categorised along with the whole plant reconstruction.

Evidence of reconstruction

With foregoing records of reconstruction of *Pentoxylon*-plant, the evidence of our attempt for the present reconstruction has been based on the constant association of long and dwarf shoots, male and female cones from the type locality of *Nipania* as well as different localities of Rajmahal Hills. Morphological and anatomical similarities that is pentamerous arrangement of vascular bundles in long shoot, leaf bearing shoot and dwarf shoot possessing female cones have proven that the vegetative and fertile organs come from one and the same plant. Additionally, the long shoots of *Pentoxylon*-plant in its helical arrangement of leaf scars bearing 5-9 vascular traces are identical to the leaf scars of foliage male and female shoots. SRIVASTAVA (1946, pl. 3, figs. 23-25) has shown the foliage dwarf shoot coming off from longshoot of *Pentoxylon* and anatomically also observed the presence of the ground tissue quite common in both type of shoots. Further, isolated pedicel of peduncle depict the same three bundles the two laterals of larger size than the third middle one and those are similar to the five groups of cortical bundles of peduncle supplied to the pedicel of five cones.

Habit

As the *Pentoxylon*-plant bears long and short (dwarf) shoots which is usually frequent among *Ginkgo*-tree that is why we could envisage that the plant should have been of arborescent habit. It could be further substantiated by evidences like mechanical cells in the outer cortex, nests of sclerotic cells and stone cells in the inner cortex. Apart from the occurrence of periderm, coniferous type secondary xylem and dwarf shoots bearing cone are some of the indirect indication of its tree nature. In the reconstruction presented here, the stem of *Pentoxylon*-plant is hypothetically drawn and its height has been assessed to be of 2-6 metres supposedly robust and crinkled. The branches presumably have been portrayed arising and dichotomizing at the extremity of stem in the form of long shoots which ultimately ramifies into dwarf (short) shoots bearing terminally or laterally borne foliage or male and female cones. The long shoots (*Pentoxylon sahnii* SRIVASTAVA 1946) bearing short shoots in the axil of sparsely placed leaf-cushions on maturity depict dwindling of leaf scars and shoot scars due to periderm formation. In the transverse section of long shoots, generally five bundles are present associated with epidermis, compact outer cortex, parenchymatous inner cortex with nests of sclerotic and stone cells. Presence of cortical bundles has been marked with little variations: one with centrifugal secondary xylem associated with a few centripetal tracheids where as the other only with the centripetal secondary xylem. However, main bundles usually consists of less centrifugal but strong centripetal secondary xylem. Unusually centripetal and centrifugal xylem are of equal development in first season growth. Afterwards the growth is more towards centripetal side than centrifugal side. Secondary phloem is preserved outside the xylem of main bundles.

Nipaniophyllum a simple, strap-shaped leaf having taeniopteroid venation are arranged in close spiral bearing anomocytic stomata. Anatomically vascular bundles are arranged in row, each surrounded by sclerenchymatous bundle sheath showing diploxylic condition that is a central protoxylem, a larger centripetal primary metaxylem mass and a small arc of centrifugal mass. The stiff coriaceous leaves are borne in the form of bunch in the apical portion of slender shoots which usually emerge in the leaf axils of long shoots. The plants were deciduous dropping off leaves in their entirety.

Plate 2.1

Plate 2.1.

A. Reconstruction of *Pentoxylon* - plant showing its tree habit. x0.18.
B. Long shoot surface showing oval scars of type - 3. slender shoots subtended by leaf scars. x0.74.
C. T.S. of long shoot of *Pentoxylon sahnii*. x4.41.
D. T.S. of type - 3 short shoot of *Pentoxylon sahnii* SRIVASTAVA showing xylem plates. x5.88.
E. Type - 3 short shoot showing bulging leaf cushions. x2.9.
F. Leaf of *Nipaniophyllum hobsonii* BOSE et al. showing venation. x0.74.
G. T.S. of petiole of *Nipaniophyllum* sp. x18.38.
H. T.S. of lamina of *Nipaniophyllum* leaf. x18.38.
I. *Nipaniophyllum* leaf showing distribution of stomata. x22.06.
J. *Nipaniophyllum* leaf showing stomata and epidermal cells. x183.83.
K. T.S. of *Nipaniophyllum* leaf showing vascular bundle of midrib. x183.83.
L. Tangential longitudinal section of *Sahnia nipaniensis* VISHNU-MITTRE. x5.88.
M. Pollen of *Sahnia nipaniensis* VISHNU-MITTRE. x220.59.
N. Type - 2. short shoot bearing *Carnoconites compactus* SRIVASTAVA. x0.74.
O. *Carnoconites compactus* cone showing ovules. x1.47.

The male cone *Sahnia nipaniensis* VISHNU-MITTRE (1953) abscissed from base has been borne on a caducous short shoot. The shoot surface is covered by helically arranged leaf-cushions and the grooves between the cushions possess unicellular hairs. The microsporophylls more or less in a whorl are branched radially or unbranched spirally or irregularly arranged on conical-cylindrical receptacle, each balloon-shaped or globose sporangium stalked, present in two lateral rows. Sporangia enclose boat-shaped elliptical or circular monocolpate pollen with reticulate exine, typically of cycadean type.

Female cone *Carnoconites* (SRIVASTAVA 1944) borne on woody short shoot, spirally attached to the peduncle with a pedicel. Peduncle in the upper part shows a central cylinder of about ten collateral bundles and in the cortex around there are always five groups of bundles which are supposed to be of supply bundles to the pedicels of five cones. Each cortical group consists of three bundles in which middle one is smaller than two lateral ones. Ovules with micropyle point outwards. Seeds platyspermic, spirally attached, outer fleshly sarcotesta and inner stony layer well developed. Nucellus free from integument, apically nucellar membrane projects into the micropyle. Vascular strand enters from chalazal end and terminates below the base of nucellus. Few seeds are with embryo. Two species recovered from Rajmahal Hills are *C. compactus* (SRIVASTAVA 1944) and *C. rajmahalensis* WIELAND (BOSE et al. 1985) have been differentiated in the nature of compact and lax arrangement of their seeds directly attached to axis. Both species of seed cones were borne on peduncles with an exception that *C. compactus* bore long pedicels where as the elongated cones of *C. rajmahalensis* possessed short pedicels. The seed of *C. rajmahalensis* as compared to *C. compactus* are more in number and smaller in size having thin sarcotesta. Further the well developed fleshy layer of these seeds after fertilization have been interpreted as to be for attracting the insects whereas the sclerotesta of these seeds must have been for protection as well as for dissemination or dispersal.

Habitat

The ongoing account of various plant organs belonging to pentoxylopsids is suggestive of the occurrence of two species of *Pentoxylon*-plant that existed during that period in the terrain of Rajmahal Hills forest. The reason being that the leaf and seed cone gen-

era are represented by two distinct species associated with other plant groups like pteridophytes and conifers. Cycadophytes are less frequent in southern part of the basin. From the entire floristic scenario of *Nipania*, it appears that the *Pentoxylon* - plant occupied the understorey in association of cycadophytes where as the conifers etc. were slightly at higher altitude. Additionally, it is worthwhile to point over here that most of the chert blocks when were examined it was found that where there was overwhelming dominance of pentoxylopsids, rarely any coniferous remains could be marked on those chert slices. This observation support for pentoxylopsids growing in the community of moisture loving plants, is also in the fitness of contention (BOSE et al., 1985) that *Pentoxylon*-plant grew beside water.

However, it could be visualized that the advent of pentoxylopsids mark a definitive floral change towards the late part of Jurassic or Early Cretaceous when this new plant group with different phyto-communities existed, and that is a subject now to ponder over it. In northern part such as (Onthea, Sakrigalighat and Mandro) of Rajmahal Basin, pentoxylopsids remains have been recovered where cycadophytes frequently occur, though their preservation is quite different probably due to taphonomical factors. Conclusively, the flora flourished along the lake margin on volcanic terrain as a part of mixed deciduous sub-tropical forest in humid climate.

Phylogenetic Interpretations

Pentoxylon-plant belongs to an unique group of gymnosperm because:

1. Secondary wood of *Pentoxylon* stem having been of coniferous type but without xylem parenchyma.
2. Bearing single-type of tracheidal pitting and different raypit field.
3. Leaf exhibit anomocytic-type of stomata having vascular traces with diploxylic condition identical to *cycads* but in its direct leaf traces, the leaf differs from cycads having girdle leaf traces.
4. Microsporophylls are borne on cylindrical receptacle showing branching, at times unbranched sac-like microsporangia quite distinct from bennettitalean synangia.
5. The ovules are borne directly on the cone axis without having any bract, ovuliferous scales or interseminal scales of perianth, an unique nature among the gymnosperm group as regards the mode of attachment of ovules.

Distribution in space and time

Besides extensive occurrence of pentoxylopsids in Nipania beds of Rajmahal Hills, India, HARRIS (1962) described *Carnoconites (C. cranwelli)* from the *Taeniopteris* bed at Port Waikato, New Zealand which has been dated as Tithonian. Later, WHITE (1981) reported male and female cones from Jurassic of Talbragar Fish Bed, New South Wales, Australia. The main trunk of *Pentoxylon*-plant was recoreded by ROZEFELDS (1982) from south east Queensland of Australia. Lately, DRINNAN and CHAMBER (1985) published a comprehensive work of pentoxylopsids (*C. cranwelli, Sahnia laxiphora* and *Taeniopteris daintreei*) from Early Cretaceous of Koonwarra Whitelaw beds of Victoria, Australia.

The palaeogeographic distribution of pentoxylopsids is suggestive of that this plant-group flourished well in the eastern part of Gondwanaland during Jurassic-Cretaceous period. Recent finding of *Taeniopteris* sp. and *Carnoconites llambiasii* by CESARI et al. (1998) indicate the occurrence of *Pentoxylales* from Early Cretaceous bed of the Byers Peninsula, South Shetland Island, Antarctica.

References

BOSE, M.N., PAL, P.K. and HARRIS, T.M. (1985): The *Pentoxylon* plant. - Phil. Trans. R. Soc. Lond. B, *310*, 77-108.

CISARI, S.N., PARICA, C. A., REMESAL, M. B. and SALANI, F. M. (1998): First evidence of *Pentoxylales* in Antarctica. – Cretaceous Research *19*, 733-743.

DRINNAN, A.N. and CHAMBERS, T.C. (1985): A reassessment of *Taeniopteris daintreei* from the Victorian Early Cretaceous a member of the *Pentoxylales* and a significant Gondwanaland plant. - Aust. J. Bot. *33*, 89-100.

HARRIS, T.M. (1962): The occurrence of the fructification Carnoconites in New Zealand. - Trans. R. Soc. New Zealand Geol. *1*, 17-29.

HOBSON, G.V. (In PASCOE, E. 1929): General Report for 1928. - Rec. Geol. Surv. of India *62*, 1-84.

RAO, A.R. (1935): Silificied plants from Rajmahal Series. - Proc. 22nd Indian Sci. Congr. Calcutta, 283.

RAO, A.R. (1936): The anatomy of *Taeniopteris spatulata* McClelland. - Proc. 23rd. Indian Sci. Congr, Indore, 304.

RAO, A.R. (1943a): *Nipaniostrobus*, a new genus of *Dacrydium*-like seed-bearing cones, and other silicified plants from the Rajmahal Series. - Proc. Indian Acad. Sci. *13*, 113-133.

RAO, A.R. (1943b): Jurassic spores and sporangia from the Rajmahal Hills, Bihar. - Proc. Natn. Acad. Sci. India *13*, 181-197.

RAO, A.R. (1943c): The structure and affinities of *Taeniopteris spatulata* McCl. - Proc. Natn. Acad. Sci. India *13*, 333-335.

RAO, A.R. (1947): The megastrobilus of *Nipanioruha granthia* gen. et sp. nov., a new petrified coniferous shoot from the Rajmahal Hills, Bihar. - J. Indian bot. Soc. Lyengar Commemoration volume, 389-397.

RAO, A.R. (1974): The *Pentoxyleae*. In: Aspects and Appraisal of Indian Palaeobotany (SURANGE, K.R., LAKHANPAL, R.N. BHARDWAJ, D.C. B.S.I.P. Lko. eds.), 201-209.

ROZEFELDS, A.C. (1982): *Pentoxylon:* An unusual fossil tree. - Austr. Gem and Treasure Hunter, 10-11.

SAHNI, B. (1932): Anatomical proof of the cycadophyte affinities of *Taeniopteris spatulata* McCl. - Proc. 19th. Indian sci. Congr. Bangalore, 322.

SAHNI, B. (1935): Recent discoveries in the Rajmahal flora. - Proc. 6th Internat. Bot. Congr. Amsterdam *2*, 248-249.

SAHNI, B. (1938): Recent advances in Indian Palaeobotany. Presidential Address. - Proc. 25th. Indian Sci. Congr. Calcutta *2*, 133-175.

SAHNI, B. (1948): *The Pentoxyleae:* A new group of Jurassic gymnosperm from the Rajmahal Hills of India. - Bot. Gaz. *110*, 47-80.

SAHNI, B. and RAO, A.R. (1933): On some Jurassic plants from the Rajmahal Hills. - J. asiat. Soc. Beng. *27*, 183-208.

SINGH, G. (1957): *Araucarites nipaniensis* SINGH. - Palaeobotanist *5*, 64-65.

SHARMA, B.D. (1969): On *Pentoxyleae* remains from Amarjola in the Rajmahal Hills, India. - Ameghiniana *6*, 50-56.

SHARMA, B.D. (1973a): Further observations on *Pentoxylon sahnii* SRIVASTAVA from the Jurassic of Amarjola in the Rajmahal Hills, India. - Palaeobotanist *20*, 216-220.

SHARMA, B.D. (1973b): On the anatomy of dwarf shoots of *Pentoxylon sahnii* SRIVASTAVA collected from Amarjola in the Rajmahal Hills, India. - Acta Paleobot. *14*, 195-204.

SHARMA, B.D. (1974): Observation on the branching in *Pentoxylon sahnii* SRIVASTAVA. - Bull. Nat. Sci. Mus. Tokyo *17*, 315-324.

SHARMA, B.D. (1975): Further observation on the Jurassic flora of *Nipania* in the Rajmahal Hills, India. - Ameghiniana *12*, 329-336.

SHARMA, B.D. (1979): Further observation on the dwarf shoot of *Pentoxylon sahnii* SRIVASTAVA collected from the Jurassic of Rajmahal Hills, India. - Acta Palaeobot. *20*, 129-136.

SHARMA, B.D. (1980): Possible occurrence of polyembryony in *Pentoxyleae*. - Phytomorphology *39*, 199-201.

SHARMA, B. D. (1996): The *Pentoxyleae*: an overview. – Palaeobotanist *45*, 50-56.

SRIVASTAVA, B.P. (1935): On some silicified plant remains from the Rajmahal Series of India. - Proc. 22nd Indian Sci. Congr. Calcutta, 285.

SRIVASTAVA, B.P. (1937): Studies on some silicified remains from the Rajmahal Series of India. - Proc. 24th Indian Sci. Congr., Hyderabad, Deccan, 273-274.

SRIVASTAVA, B.P. (1944): Silicified plant remains from the Rajmahal Hills,. Palaeobotany in India, 5. - Proc. natn. Acad. Sci, India, *14*, 73-76.

SRIVASTAVA, B.P. (1946): Silicified plant remains from the Rajmahal Series of India. - Proc. natn. Acad. Sci. India *15*, 185-211.
SUTHER, O.P. and SHARMA, B.D. (1988): A new interpretation on the structure of *Sahnia nipaniensis* VISHNU MITTRE from the Rajmahal Hills. - Palaeobotanist *37*, 90-93.
VISHNU-MITTRE (1952): Charophyte remains from the Jurassic of Rajmahal Hills, Bihar. - Curr. Sci. *21*, 41-42.
VISHNU-MITTRE (1953): A male flower of the *Pentoxyleae* with remarks on the structure of the female cones of the group. - Palaeobotanist *2*, 75-84.
VISHNU-MITTRE (1955): Petrified spores and pollen grains from the Jurassic rocks of Rajmahal Hills, Bihar. - Palaeobotanist *3*, 117-127.
VISHNU-MITTRE (1958): Studies on the fossil flora of *Nipania* (Rajmahal Series), India - Pentoxyleae. - Palaeobotanist, *6*, 31-46.
VISHNU-MITTRE (1969): Nuclei and Chromosomes in a fossil fern. Chromosomes Today *2*, 250-251.
WHITE, M.E. (1981): Revision of the Talbragar Fish Bed Flora (Jurassic) of New South Wales. - Rec. Aust. Mus. *33*, 695-721.
WHITE, M. E. (1990): The Greening of Gondwana. – Reed Books Pty. Ltd. Sydney Road, N.S.W. Australia, 1-256.

3. UPPER CRETACEOUS POLLEN GRAINS FROM EGYPT VI.

M. KEDVES

Cell Biological and Evolutionary Micropaleontological Laboratory of the University of Szeged, H-6701, P.O. Box 993, Szeged, Hungary

Abstract

Intratriporopollenites aegypticus n. fsp. is described in this short communication. The most important earliest occurrences of the fossil "tilioide pollen grains" is discussed. In the context of Africa the new pollen grain described is the oldest.

Key words: Palynology, fossil, *Tiliaceae*, Upper Cretaceous, Egypt.

Form-genus: *Intratriporopollenites* PFLUG et THOMSON 1953

Triaperturate pollen grains, the well developed endanuli are the most important characteristic features of these fossil *Tiliaceae* pollen grains. Further taxonomic information about Tertiary species was published by MAI (1961). In the original diagnosis, the sculpture was not mentioned. MAI (1961) added the presence of a reticulate sculpture to the diagnosis.

Intratriporopollenites aegypticus n. fsp.
(Plate 3.1., figs. 1-8)

Diagnosis: Amb circular to triangular, with concave sides. Surface smooth to scabrate. The inter-apertural exine is 2.6-3.2 µm thick and the foot layer is relatively very thick, T/I/F = 1.5-2/1/4-5. Structure finely intrabaculate. The furrows are 10-18 µm long and are bordered by a 2 µm wide thickened zone. Endannulus is about 3-4 µm wide.

Diameter: 33 µm; 30-38 µm.

Holotype: Plate 3.1., figs. 1-4, slide: Farafra-6-2-1-8; cross-table number: 7.6/106.4.

Locus typicus: Farafra, Maestrichtian, Nubia Sandstone.

Stratum typicum: clay.

Derivatio nominis: From Egypt.

Differential diagnosis: Based on the emended diagnosis by MAI (1961), this species may not belong to this form-genus, because of its non-reticulate surface, which distinguishes it from the other species of *Intratriporopollenites*. Further information is necessary to decide whether or not these non-reticulate Tilioide-forms represents another new form-genus . In any case these "aegypticus type" forms may be the earliest *Tiliaceae* pollen from North Africa.

Botanical affinity: *Tiliaceae.*

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-1), infrequent.

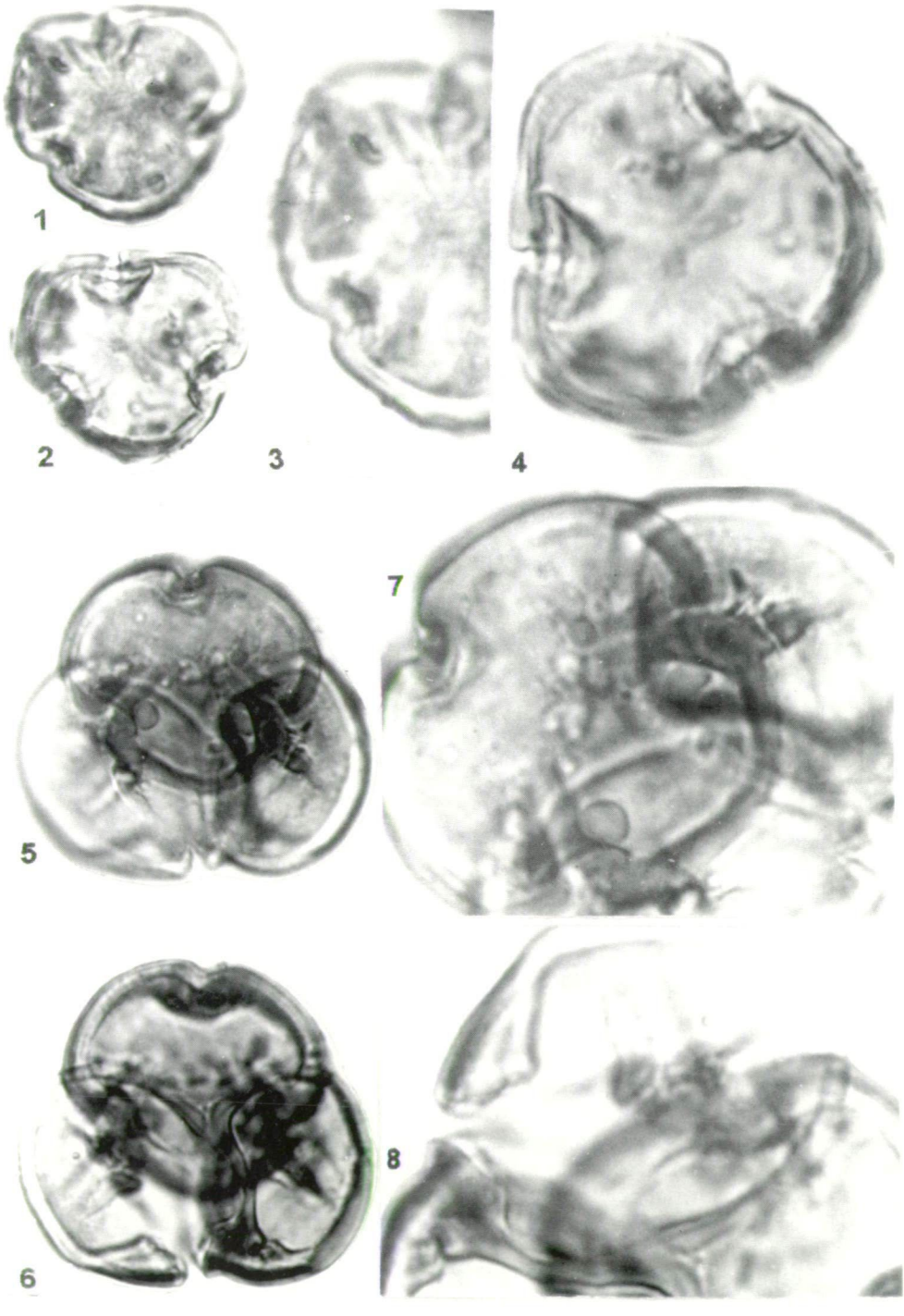


Plate 3.1.

Plate 3.1.

1-8. *Intratriporopollenites aegypticus* n. fsp., *Tiliaceae*.
1,2. Slide: Farafra-6-2-S1, cross-table number: 7.6/106.4, 1000x.
3,4. Slide: Farafra-6-2-S1, cross-table number: 7.6/106.4, 2000x.
5,6. Slide: Farafra-6-2-S1, cross-table number: 20.4/103.6, 1000x.
7,8. Slide: Farafra-6-2-S1, cross-table number: 20.4/103.6, 2000x.

Remarks: Following MULLER (1981) the *Tilia* type pollen grains appeared in the Paleocene. He pointed out the following, p. 45: "The first appearance of the *Tilia* type thus appears to be approximately contemporaneous in Europe and North America." *Tilia wodehousei* n.sp. was described by ANDERSON (1960) from the Kirtland shale florule, Uppermost Cretaceous, San Juan Basin, New Mexico. *Tiliaepollenites indubitabilis* POTONIÉ was published by SONG ZHICHEN et al. (1981) from Cretaceous-Tertiary layers of northern Jiangsu. Paleocene/Eocene occurrences were published by DOERENKAMP, JARDINÉ and MOREAU (1976), *Tiliaepollenites* and by KRUTZSCH (1957), "Gruppe 71: sog. " + glatte tilioide-Formen".

Finally it seems that the Upper Cretaceous *Tiliaceae* pollen grain from Egypt is the oldest within this kind of pollen grains.

References

ANDERSON, R.Y. (1960): Cretaceous-Tertiary Palynology, Eastern Side of the San Juan Basin, New Mexico. - State Bur. Min. and Miner. Res. New Mexico Inst. Mining and Techn. *6*, 1-59.

DOERENKAMP, G., JARDINÉ, S. and MOREAU, P. (1976): Cretaceous and Tertiary palynomorph assemblages from Banks Island and Adjacent areas (N.W.T.). - Bull. Canad. Petroleum Geol. *24*, 321-371.

KRUTZSCH, W. (1957): Sporen- und Pollengruppen aus der Oberkreide und dem Tertiär Mitteleuropas und ihre stratigraphische Verteilung. - Zeitschrift für angew. Geol. *11/12*, 509-548.

MAI, D.H. (1961): Über eine fossile *Tiliaceen*-Blüte und tilioiden Pollen aus den deutschen Tertiär. - Geologie *10* BH *32*, 54-93.

MULLER, J. (1981): Fossil pollen records of extant *Angiosperms*. The Bot. Rev. *47*, 1-146.

PFLUG, H.D. und THOMSON, P.W. (1953): In: THOMSON, P.W. und PFLUG, H.D.

THOMSON, P.W. und PFLUG, H.D. (1953): Pollen und Sporen des mitteleuropäischen Tertiär. - Palaeontographica *B, 94*, 1-138.

SONG ZHICHEN, ZHENG YAHUI, LIU JINGLING, YE PINGYI, WANG CONG FEN and ZHOU SHAN FU (1981): Cretaceous-Tertiary sporo-pollen assemblages of northern Jiangsu. - Geol. Publ. House, Beijing (Chinese with English summary).

4. LM AND TEM INVESTIGATIONS ON THE UPPER CRETACEOUS AJKAITE OF HUNGARY II.

M. KEDVES, A. BORBOLA and K. PRISKIN

Cell Biological and Evolutionary Micropaleontological Laboratory of the University of Szeged, H-6701, P.O. Box 993, Szeged, Hungary

Abstract

This paper presents the LM morphology of the woody remnants of the amber containing brown coal samples and the ultrastructure of a peculiar fossil *angiosperm* pollen grain. Based on the xylem remnants *Pteridophyta, Cycadophyta, Coniferophytina*, ancient *dicotyledonous* taxa and *Palmae* may be presumed. Among the *Coniferophytina* it is worth mentioning the lack of the *Araucariaceae* tracheids, because of the presence of the *Araucariaceae* pollen grains in the samples. The amber in the *dicotyledonous* vessel is evidence of the *angiosperm* origin of the Ajkaite. The perforation type of the vessel is printed in the fossil resin remnant. This kind of vessel occurs in the Cretaceous and at the *Magnoliaceae*, and particularly in the *Amentiflorae*. The new TEM data, which are concerning the genus *Complexiopollis* KRUTZSCH 1959 em. TSCHUDY 1973, are different from the previously published ones. In the investigated specimen the protoplasm was not preserved.

Key words: Plant microfossils, LM, TEM, Upper Cretaceous, Ajkaite.

Introduction

In our previous paper the aim of our investigations was published (KEDVES, SZÓNOKY, MADARÁSZ and KOVÁCS, 2000). In this paper the program of this kind of research is just shortly summarized. The importance of the LM structure of the secondary xylem elements in the Ajkaite containing brown coal such as in the reconstruction of the "amber tree" was emphasized. The aim of this part of investigation is to get some information for the origin of the Ajkaite producing tree. The "partial xylotomy" namely the presence of the woody fragments in the palynological assemblage was used previously in several papers, e.g.: ZANDER (1923), WILSON (1971), SCHRANK (1984), DUTTA, BHUYAN and KUMAR (1998), KHANDEVAL ASGA and GUPTA (1994), etc. The TEM data of *Complexiopollenites* pollen grain is included in the program of our studies on the protoplasm of the fossil spore and pollen taxa, but till this time has not been succesful. But the ultrastructure of the exine is a peculiar type within the *Complexiopollis* genus.

Materials and Methods

The data of the two Ajkaite containing coal samples were published in the previously mentioned paper. For the present LM investigations 25 slides were investigated from each sample. Different kinds of xylem remnants were investigated statistically. The epidermis fragments were noticed without nearer determination.

For ultrastructure investigations the amber was ultrathin sectioned in this way without any fixation, in natur of condition. The pictures were taken in the EM Laboratory of the Department of Biophysics of the Biological Research Center of the Hungarian Academy of Sciences on a Tesla BS-540 instrument (resolution 6-7 Å).

Results

1. LM results

Sample	KG-99	SZM-99
Number of the observed plant tissue remnants:	1543	1933
Number of the secondary xylem and resinous remnants:	208	152
Number of the epidermis remnants:	1335	1781

Types of the different secondary xylem remnants

Cycadopsida, Pteridophyta or *Palmales* remnants

Type A. Scalariform thickenings of tracheids (Plate 4.1., figs. 1-3).

Fig. 1. - The lumen of the tracheids are 11-38 μm. GREGUSS (1968) in his monograph on the Xylotomy of the living *Cycads* compared this type with the vessel of palms and the branched scalariform thickenings of *Sigillaria*. Among the recent *Cycadales* the genus of *Microcycas* was pointed out. Similar structures were published in this monographs at the following species: *Cycas circinalis* L., *Stangeria paradoxa* TH. MOORE, *Macrozamia macdonnelli* (F. MUELL.) A.DC., *Microcycas calocoma* (MIQ.) A.DC., *Ceratozamia mexicana* BRONGN., *Zamia angustifolia* (JACQ.) SCHUSTER, *Z. floridana* A.DC., *Z. gutierrezi* SAUVALLE, *Z. obidensis* DUCKE, *Z. portoricensis* URBAN, *Z. pumila* L., *Z. silicea* BRITTON. GREGUSS (1969) described the *Palmoxylon dorogense* with similar tracheid thickenings. Figs. 2,3. - Similar to the previous one, but the elements are narrower; *Encephalartos barteri* CARRUTHERS, *E. septentrionalis* SCHWEINF., *E. villosus* (GAERTN.) LEMAIRE, *Dioon edule* LINDL., *D. spinulosum* DYER. Similar tracheids were published by STROTHER and TRAVERSE (1979) from Silurian rocks from Pennsylvania, U.S.A.

Type B. Scalariform thickenings of tracheids sometimes with areolate pits (Plate 4.1., figs. 4-6).

Type C. Similar to Type B, but the elements of the scalariform thickenings are rare (Plate 4.1., figs. 7-9).

Gymnospermatophyta, Coniferophytina remnants

Type D. Fibre tracheid (Plate 4.1., fig. 10).

Type E Areolate, bordered pits of slit-like type (Plate 4.1., figs. 11,12). - In the book of GREGUSS (1955) this kind of bordered pit occurs at the following recent taxa: *Austrotaxus spicarus* COMPT., *Phyllocladus trichomanoides* D. DON., *Podocarpus macrophyllus* D. DON., *Callitropsis araucarioides* COMPT. Further data were published by GREGUSS (1972): *Dacrydium falciforme* PILGER, *D. intermedium* T. KIRK, *D. westlandicum* T. KIRK, *Podocarpus nubigenus* LINDLEY, *P. pilgeri* FOXW., *P. sellowii* KLOTZSCH, *P. ustus* BRONGN. and GRIS.

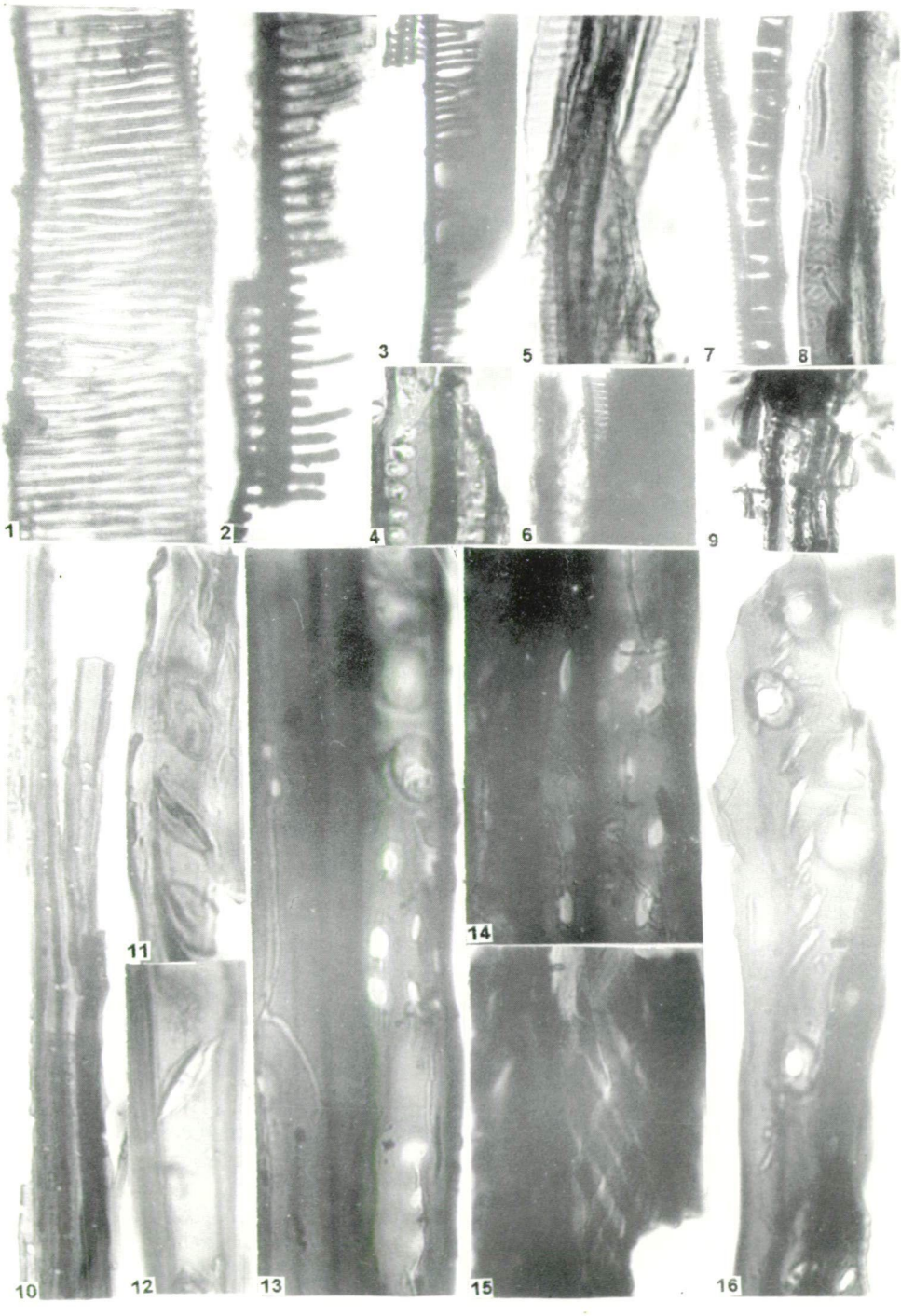


Plate 4.1.

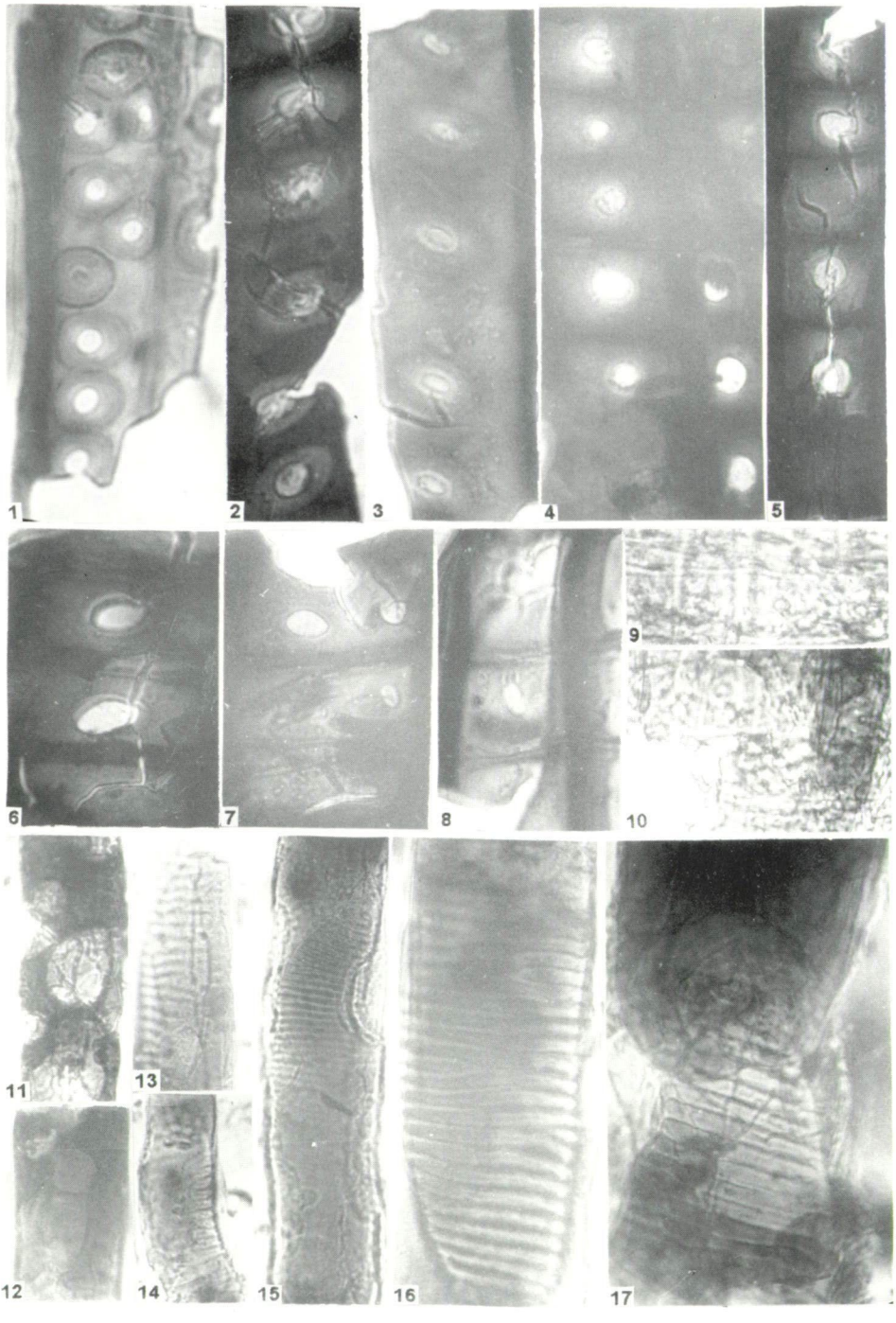


Plate 4.2.

Plate 4.1.

1 - 3. Type A; 1. slide: KG-99-11, cross-table number: 13.8/138.2 670x, 2. slide: KG-99-18, cross-table number: 24.0/127.7 670x, 3. slide: KG-99-18, cross-table number: 24.0/127.7 335x.
4 - 6. Type B; 4. slide: KG-99-11, cross-table number: 22.2/137.3 670x, 5. slide: KG-99-14, cross-table number: 18.4/129.8 670x, 6. slide: KG-99-11, cross-table number: 10.1/142.2 335x.
7 - 9. Type C; 7. slide: KG-99-15, cross-table number: 13.3/140.1 335x, 8. slide: KG-99-21, cross-table number: 19.6/140.0 670x, 9. slide: KG-99-10, cross-table number: 14.2/126.8 335x.
10. Type D; slide: KG-99-15, cross-table number: 12.3/130.6 670x.
11,12. Type E; 11. slide: SzM-99-8, cross-table number: 22.9/138.1 670x, 12. slide: SzM-99-12, cross-table number: 15.3/133.4 670x.
13,14. Type F; 13. slide: KG-99-14, cross-table number: 24.7/139.5 670x, 14. slide: KG-99-9, cross-table number: 8.4/126.7 670x.
15. Type G; slide: SzM-99-12, cross-table number: 11.5/140.2 670x.
16. Type H; slide: KG-99-12, cross-table number: 17.1/125.1 670x.

Plate 4.2.

1 - 5. Type H; 1. slide: KG-99-17, cross-table number: 22.2/135.8, 670x, 2. slide: KG-99-14, cross-table number: 14.4/133.8, 670x, 3. slide: KG-99-7, cross-table number: 25.8/145.4, 670x, 4. slide: KG-99-7, cross-table number: 11.3/139.3, 670x, 5. slide: KG-99-13, cross-table number: 19.7/136.5, 670x.
6 - 8. Type I; 6. slide: KG-99-14, cross-table number: 7.8/140.8, 670x, 7. slide: KG-99-24, cross-table number: 24.5/134.5, 670x, 8. slide: KG-99-13, cross-table number: 15.8/138.8, 670x.
9, 10. Type J; slide: SzM-99-12, cross-table number: 24,8/124.4, 670x.
11, 12. Type K; 11. slide: SzM-99-9, cross-table number: 17.9/140.8, 335x, 12. slide: SzM-99-13, cross-table number: 18.6/137.8, 335x.
13 - 17. Type L; 13. slide: SzM-99-18, cross-table number: 11.9/125.7, 335x, 14. slide: SzM-99-6, cross-table number: 15.2/136.3, 335x, 15. slide: SzM-99-5, cross-table number: 24.3/126.4, 335x, 16. slide: SzM-99-14, cross-table number: 11.7/128.7 670x, 17. slide: SzM-99-14, cross-table number: 19.7/139.9, 335x.

Type F. Areolate, bordered pits of modern type with cross fields pits (Plate 4.1., figs. 13,14). Probably *Podocarpaceae* (GREGUSS,1955, 1958), it is some similarity with the fusit remnants published by GREGUSS (1948) from the Upper Cretaceous brown-coal layers of Ajka and with *Podocarpoxylon svanidzei* BARALE, JACOBIDZE, LEBANIDZE and PHILLIPPE (1991), from the Bathonian coal formation of West Georgia.

Type G. Tracheid fragment of spiral thickenings (Plate 4.1., fig. 15). - An early type, probably reworked or their spiral thickenings are secondary characters during the fossilization processes. From the Permian layers GREGUSS (1961) described the *Platyspiroxylon heteroparenchymatosum* with similar or identical thickenings.

Type H. Tracheids with areolate, bordered pits of modern type (Plate 4.1., fig. 16, plate 4.2., figs. 1-5). From the Upper Cretaceous layers of Egypt this kind of areolate thickening was published by SCHRANK (1984). Based on the monograph of GREGUSS (1955) a great number species from the following family has similar anatomical characteristics: *Podocarpaceae, Cupressaceae, Taxodiaceae, Pinaceae.*

Type I. Cross fields of *taxodioid* or *podocarpoid* pitting (Plate 4.2., figs 6-8).

Type J. Cross fields of *cupressoid* pitting (Plate 4.2., fig. 9,10).

Type K. Resinous remnants with bubbles, probably of *taxodioid* origin (Plate 4.2., figs. 11,12).

Type L. Resinous remnant with the pattern of scalariform vessel perforation (Plate 4.2., figs. 13-17). - Based on the book of GREGUSS (1945) on the wood anatomy Cen-

tral European *Dicotyledonous* trees and shrubs, this kind of xylem remnant occurs at the following recent taxa: *Betula humilis* SCHRANK., *B. nana* L., *B. pendula* ROTH., *B. pubescens* EHRH., *Alnus incana* (L.) MOENCH., *A. glutinosa* (L.) GAERTN., *A. viridis* (CHAIX) LAM. et D.C., *Corylus avellana* L., *C. maxima* MILL., *Myrica gale* L., *Buxus sempervirens* L., *Hamamelis virginiana* L., *Cercidiphyllum japonicum* S. et Z., *Platanus orientalis* L., *Magnolia acuminata* L., *Liriodendron tulipifera* L., *Philadelphus coronarius* L., *Ribes uva-crispa* L., *R. alpinum* L., *R. silvestre* MEST. et KOCH., *Tilia platyphyllos* SCOP., *T. americana* L., *Acer platanoides* L., *Ilex aquifolium* L.,*Vitis vinifera* L., *Cornus mas* L., *C. sanquinea* L., *Rhododendron kotschyi* SIMK., *R. hirsutum* L., *Rhodothamnus chamaecistus* (L.) RCHB., *Loiseleuria procumbens* (L.) DESV., *Ledum palustre* L., *Andromeda polifolia* L., *Erica tetralix* L., *Vaccinium myrtillus* L., *V. uliginosum* L., *V. oxycoccus* L., *Chamaedaphne calyculata* (L.) MOENCH., *Empetrum nigrum* L., *Viburnum opulus* L., *V. lantana* L., *Linnaea borealis* L. In the monograph of the Tertiary *angiosperm* woods in Hungary similar or identical vessel perforations were published by GREGUSS (1969): *Palmoxylon sabaloides* GREGUSS 1954, *Liquidambaroxylon weylandii* GREGUSS 1969, *L. horváthi* GREGUSS 1969, *L. mägdefraui* GREGUSS 1969, *L.* cf. *speciosum* FÉLIX 1884, *L. cf. styraciflua*, *Ilioxylon theresiae* GREGUSS 1969, *I.* cf. *aquifolium* (HOFMANN 1939) GREGUSS 1943a, *Citronella* cf. *mucronata* D. DON., *Icacinoxylon citronelloides* SHILK. 1958, *I.* cf. *citronelloides* SHILK. 1958), *I. cf. goderdzicum* SHILK. 1958, *I. hortobágyii* GREGUSS 1969, *I. laticiphorum* GREGUSS 1969, *I. crystallophorum* GREGUSS 1969, *I. shilkinae* GREGUSS 1969, *I. sylvaticum* (TUZSON 1906) GREGUSS 1969, *Alnus* sp., *Euphorbioxylon secretiphorum* GREGUSS 1969, *Fraxinoxylon* cf. *Fraxinus excelsior* L. ANDREÁNSZKY (1955).

The quantitative data of the different xylem remnants are summarized as follows.

Types	Sample 1	Sample 2
	KG-99	*SZM-99*
A	6	2
B	10	-
C	4	-
D	6	-
E	14	4
F	2	-
G	-	1
H	152	64
I	6	2
J	-	1
K	-	2
L	7	36

The analogies and the differences are well shown in the quantitative data of the woody remnants in the two different sample. The occurrence of scalariform vessel remnants (Type L) is important in the 2nd sample.

Plate 4.3.

Plate 4.3.

1,2. Ultrastructure of the exine of a *Complexiopollis* fsp. from the Ajkaite.
1. Block number: KG-03, negative number: 8463, 10.000x.
2. Block number: KG-03, negative number: 8964, 25.000x.

---

2. TEM results

During our investigations we observed an interesting exinous remnant from the genus *Complexiopollis* W. KR. 1959 em. TSCHUDY 1973 (Plate 4.3., figs. 1,2).

The plane of the sectioning was near the apertures. Tectum is thin imperforate. In the inter-apertural area the infratectum is composed of more or less globular sometimes anastomosing elements. This layer is followed by a large in all probably another infratectal layer similar to the *Cycadaceous* radially oriented alveolar structure. A thin foot layer is beneath the infratectum. As regards the apertural area our data are not complete. Some lamellar or irregular apertural elements are present. Endexine was not observed. The infratectum is in this area also two layered, but the outer layer is not granular, it is irregular or alveolar. The inner layer seems to be fragmented.

Discussion and Conclusions

1. Based on the fragmented xylotomical data the following may be emphasized:

1.1. Pollen grains of *Araucariaceae* occurred in the coal samples, but xylotomical data was not found for this family.

1.2. *Podocarpaceae* is probably by the xylotomical data but pollen grains of *Podocarpaceae* has not been found till this time.

1.3. *Taxodiaceae, Cupressaceae* and *Pinaceae* remnants are probably based on the palynological and xylotomical data.

1.4. *Pteridophyta* spores and tissue remnants are present, but the *Cycadaceae* and *Palmae* are also probably based on the xylem remnants.

1.5. In all probability the origin of the Ajkaite is a *Dicotyledonous* wood, of extinct *Amentiflorae*, which is represented by the great quantity of *Normapolles* taxa in the brown coal of Ajka. The scalariform vessel perforation is extremely frequent in the Cretaceous time based on the work of HERENDEN, WHEELER and BAAS (1999). From the recent taxa *Magnoliaceae, Degeneriaceae, Eupomatiaceae, Illiciaceae, Austrobaileyaceae, Trimeniaceae* and *Chloranthaceae* are worth mentioning.

2. The transmission electronmicroscopical results are peculiar taking into consideration the previous ultrastructural data in this subject. The first data on the *Complexiopollis praeatumescens* KRUTZSCH 1959 was published by HEGEDÜS, KEDVES and PÁRDUTZ (1971,1972, KEDVES 1990). Further TEM data of this form-genus - *C. vancampoae* DINIZ, KEDVES and SIMONCSICS 1977, *C. helmigii* (VAN AMEROM 1965) SOLÉ DE PORTA 1978 were published by KEDVES and PÁRDUTZ (1982). Endexine, lamellar foot layer were described in the apertural area, and the apertural infratectal layer is more or less granular. In the inter-apertural area the infratectal layer is columellar.

In our new TEM data we need to point out the following:

2.1. No endexine in the apertural area.

2.2. The apertural infratectal layer is irregular or alveolar. Lamellar foot layer is present.

2.3. The two kinds of infratectal layer (granular and alveolar) in the inter-apertural area was the first presented in the *Normapolles* taxa. The granular infratectum is characteristic to the *Amentiflorae*, the inner layer of *Gymnosperm, cycadaceous* affinity. In contrast to the previously mentioned taxa of the form-genus *Complexiopollis* KRUTZSCH 1959 emend TSCHUDY 1973, the granular infratectum is characteristic to the apertural area, and the inter-apertural infratectum is columellar. In this way this new TEM data is unusual and peculiar.

Finally the xylotomical and the TEM data of the *Normapolles* exines reveals to the *Amentiflorae* concerning the "amber tree" of the Upper Cretaceous Ajkaite.

Acknowledgements

This work was supported by the Grant OTKA T/9 02308 and DT. 2000. máj./1. The writers are deeply indebted to Ass. Prof. K. BABOS (Department of Applied Botany of the University of Budapest) for reading critically this manuscript and his valuable comments.

References

AMEROM, VAN H. W. J. (1965): Upper-Cretaceous pollen and spores assemblages from the so-called "Wealden" of the province of Leon (Northern Spain). - Pollen et Spores *7*, 93-133.

ANDREÁNSZKY, G. (1954): Ősnövénytan (Paleobotany). - Akadémiai Kiadó, Budapest.

ANDREÁNSZKY, G. (1955): Neue und interessante Pflanzenarten aus Ungarn. - Ann. Hist. Nat. Mus. Nat. Hung. *6*, 37-50.

BARALE, G., IACOBIDZE, E., LEBANIDZE, Z. and PHILIPPE, M. (1991): *Podocarpoxylon svanidzei* n. sp. (*Coniferae*) du Bathonien de Tkibouli en Géorgie occidentale (URSS). - N. Jb. Geol. Paläont. Mh. *8*, 443-457.

DINIZ, F., KEDVES, M. and SIMONCSICS, P. (1977): Les sporomorphes principaux de sédiments crétacés de Vila Flor et de Carrajão, Portugal. - Com. dos Serv. Geol. de Portugal *58*, 161-178.

DUTTA, S. K., BHUYAN, D. and KUMAR, M. (1998): Record of palynodebris from the Upper Disang - Lower Barail groups around Kohima District, Nagaland. - Geophytology *27*, 61-65.

FÉLIX, J. (1884): Magyarország faopáljai paleophytologiai tekintetben (Wood opals of Hungary in paleophytological respect). - M. Kir. Földt. Int. Évk. *7*, 1-42.

GREGUSS, P. (1943a): Bemerkungen zu der Arbeit "Verkieselte Hölzer aus dem Sarmat des Tokaj-Eperjeser Gebirges" von E. Hofmann. - Földt. Közl. *73*, 582-590.

GREGUSS, P. (1945): Bestimmung der mitteleuropäischen Laubhölzer und Sträucher auf xylotomischer Grundlage. - The Hungarian Museum of Natural History, Budapest.

GREGUSS, P. (1949): Az ajkai felsőkrétakorú barnakőszén fuzitzárványának meghatározása (*Podocarpoxylon ajkaense* nov. sp.). Bestimmung des Fusit-Einschlusses der Braunkohle von Ajka aus der oberen Kreidezeit (*Podocarpoxylon ajkaense* nov. sp.). - Földt. Közl. 1949, 9-12.

GREGUSS, P. (1954): Az ipolytarnóci alsómiocén famaradványok (Lower Miocene wood remains of Ipolytarnóc). - Földt. Közl. *84*, 91-110.

GREGUSS, P. (1955): Xylotomische Bestimmung der heute lebenden *Gymnospermen*. - Akadémiai Kiadó, Budapest.

GREGUSS, P. (1956): Pflanzenreste aus der Kreidezeit von Tata. - Acta Biol. N.S. *2*, 39-49.

GREGUSS, P. (1957): Ein Lignit aus dem Miozän von Rixhöft. - Abh. Deutschen Akad. Wiss. zu Berlin, Chemie, Geologie und Biologie 1957, *3*, 3-10.

GREGUSS, P. (1958): Xylotomische Bestimmung der Koniferen-Familien. - Wissenschaftliche Zeitschrift der Pädagogischen Hochschule Potsdam *3*, 165-180.

GREGUSS, P. (1959): A palm trunk from the Lower Miocene coal basin of Salgótarján. - The Paleobotanist *8*, 19-21.

GREGUSS, P. (1961): Permische fossile Hölzer aus Ungarn. - Palaeontographica B. *109*, 131-146.

GREGUSS, P. (1967): Fossil gymnosperm woods in Hungary. - Akadémiai Kiadó, Budapest.

GREGUSS, P. (1968): Einführung in die Paläoxylotomie. - Geologie, *17*, BH. *60*, 1-88.
GREGUSS, P. (1968): Xylotomy of the living *Cycads* with a description of their leaves and epidermis. - Akadémiai Kiadó, Budapest.
GREGUSS, P. (1969): Tertiary angiosperm woods in Hungary. - Akadémiai Kiadó, Budapest.
GREGUSS, P. (1972): Xylotomy of the living *Conifers*. - Akadémiai Kiadó, Budapest.
HEGEDŰS, M., KEDVES, M. and PÁRDUTZ, Á. (1971): Ultrastructural investigations on fossil *angiosperm* exines of Upper Cretaceous. - Advancing Frontiers of Plant Sciences *28*, 317-329.
HEGEDŰS, M., KEDVES, M. and PÁRDUTZ, Á. (1972): Ultrastructural investigation of Upper Cretaceous Angiosperm exines II. - Acta Biol. Szeged. *18*, 55-69.
HERENDEEN, P.S., WHEELER, E.A. and BAAS, P. (1999): *Angiosperm* wood evolution and the potential contribution of paleontological data. - The Botanical Review *65*, 278-300.
HOFMANN, E. (1939): Kovásodott famaradványok a Tokaj-Eperjesi Hegység szarmatakori riolittufáiból (Silicified woods from the Sarmatian rhyolite tuff of the Tokaj-Eperjes Mountains). - Tisia Debrecen *3*, 260-270.
JANE, F.W. (1970): The structure of wood. - Neill and Company LTD, Edinburgh.
KEDVES, M. (1990): Transmission electron microscopy of the fossil *Angiosperm* exines. - Szeged.
KEDVES, M. and PÁRDUTZ, Á. (1982): Ultrastructural investigations of the early *Normapolles* taxa *Complexiopollis* and *Limaipollenites*. - Palynology *6*, 149-159.
KEDVES, M., SZÓNOKY, M., MADARÁSZ, M. and KOVÁCS, G. (2000): LM and TEM investigations on the Upper Cretaceous Ajkaite, of Hungary I. - Plant Cell Biolology and Development (Szeged) *12*, 8-17.
KHANDELWAL ASGA and GUPTA, H.P. (1994): Organodebris analysis of Chilka Lake, Orissa, India : An Assesment of depositional environment. - Palaeobotanist *42*, 215-224.
KRUTZSCH, W. (1959): Einige neue Formgattungen und -Arten von Sporen und Pollen aus der mitteleuropäischen Oberkreide und dem Tertiär. - Palaeontographica *B. 105*, 125-157.
POOLE, I. and FRANCIS, J.E. (1999): The first record of fossil *atherospermataceous* wood from the Upper Cretaceous of Antarctica. - Rev. Palaeobot. Palynol. *107*, 97-107.
SCHRANK, E. (1984): Organic-geochemical and palynological studies of a Dakhla Shale Profile (Late Cretaceous) in South east Egypt Part A: Succession of microfloras and depositional environment. - Berliner geowis. Abh. A, *50*, 189-207.
SHILKINA, I. A. (1958): The fossil woods of the Gederdzy Pass. - Paleobotanika *3*, 125-178. (Russian)
SOLÉ DE PORTA, N. (1978): Palinologia de dos secciones del Cenomaniense de los alrededores de Oviedo (España). - Palinologia, num. extraord. *1*, 435-441.
STROTHER, P.K. and TRAVERSE, A. (1979): Plant microfossils from Llandoverian and Wenlockian rocks of Pennsylvania. - Palynology *3*, 1-21.
TSCHUDY, R. H. (1973): *Complexiopollis* pollen lineage in Mississippi embayment rocks. - Contributions to Paleontology Geol. Surv. Prof. Paper 743-C, C1-C15.
TUZSON, J. (1906): A balatoni fosszilis fák monográfiája. - A Balaton Tudományos Tanulmányozásának Eredményei, I.
WILSON, L.R. (1971): Palynological techniques in deep-basin stratigraphy. - Shale Shaker *21*, 124-139.
ZANDER, R. (1923): Ein Beitrag zur Kenntnis der tertiären Braunkohlenhölzer des Geiseltals. - Braunkohle *22*, 17-42.

5. TRANSMISSION ELECTRON MICROSCOPY OF THE PARTIALLY DEGRADED POLLEN GRAINS FROM THE THANETIAN LAYERS OF MENAT (FRANCE) II.

M. KEDVES[1], Á. PÁRDUTZ[2] and M. MADARÁSZ[1]

1. Cell Biological and Evolutionary Micropaleontological Laboratory of the Department of Botany of the University of Szeged, H-6701, P.O. Box 993, Szeged, Hungary, 2. Institute of Biophysics, Biological Research Center of the Hungarian Academy of Sciences, H-6701, P.O. Box 521, Szeged, Hungary

Abstract

The new partial degradation experiments damaged the ultrastructure of the pollen grains heavily. The 2-aminoethanol and the $KMnO_4$ treatment 24 hours was destructive. In several cases the nearer determination of the pollen grain was impossible. In this way at this fossil material the previously used solvent, the merkaptoethanol seems to be appropriate for the moderate, partial dissolution to discover ontogenetically or taphonomically important ultrastructural elements.

Key words: Palynology, Paleocene, Menat, France, experimental ultrastructure.

Introduction

In our previous paper (KEDVES and MADARÁSZ, 2000) moderately degraded pollen grains were investigated with the TEM method. To continue this research program we increased the intensity of the partial degradation. Two experiments were carried out.

The aim of this paper to establish the resistance of the originally well preserved fossil Paleocene material.

Materials and Methods

Two kinds of experiment were carried out: 1. M-69: 20 mg dry organic material + 1 ml 2-aminoethanol, temperature 30 °C, length of time: 24h. 2. M-70: 20 mg dry organic material + 1 ml 2-aminoethanol, temperature 30 °C, length of time 24h. After washing with distilled water 10 ml $KMnO_4$ aq. dil. was added to the organic remnants for 24h at 30 °C. For TEM studies the washed material was postfixed in OsO_4 aq. dil and embedded in Araldite (Durcupan, Fluka). The ultrathin sections were made on a Porter Blum ultramicrotome with glass knives. In contrast to the previous experiments the stronger degradation made it possible to section the whole organic material. The investigations were made on a Tesla BS-540 instrument (resolution 6-7 Å) in the EM Laboratory of the Department of Biophysics of the Biological Research Center of the Hungarian Academy of Sciences.

Results

1.a. Block: M-69-1, cf. *Cupuliferoidaepollenites quisqualis* (POTONIÉ 1934) POTONIÉ 1960, *Fagaceae* or *Leguminosae* (Plate 5.1., figs. 3,4)

Thick perforated tectum and foot layer was observed. The infratectal layer was in all probability degraded. The embedding organic material sometimes closely connected to the tectum. Lamellar structures are characteristic in general without electron dense globular units.

1.b. Block: M-69-3, cf. *Cupuliferoidaepollenites quisqualis* (POTONIÉ 1934) POTONIÉ 1960, *Fagaceae* or *Leguminosae* (Plate 5.1., figs. 1,2)

On the tectum electron dense layer of the embedding organic material is closely connected to the surface. The perforations of the tectum are perceptible in the semitangential part of the section. The granular infratectal layer is not so well perceptible.

Remark. - The preservation of the ultrastructure of the two similar pollen types is completely different.

2. Block: M-69-2, cf. *Triporopollenites* fsp. (Plate 5.1., fig. 5)

The embedding material is characteristically, lamellar. The exact determination of the ectexine layer was not possible. A peculiar electron dense layer can be seen on the surface of the tectum. Exoaperture with annulus is perceptible, but the infratectal layer and the foot layer disintegrated.

3. Block: M-70-4, cf. *Classoidites* fsp. ectexine (Plate 5.2., fig. 1)

Compressed and damaged ectexine was observed. Spinae are on the surface of the tectum, which is in all probability perforated. Tiny columellar layer is connected to the originally large infratectal layer composed of irregular elements. A secondary homogenisation is also well illustrated. The endexine was not perceptible.

4. Block: M-70-2, Echinate *Brevaxones* pollen (Plate 5.2., figs. 2,3)

In all probability the ectexine of a large tri- or subtriporate pollen grain was observed. Echinate tectum, and columellar infratectal layer was observed. There are electron dense granules or filaments in the more or less homogeneous ectexine.

5. Block: M-69-4, compressed mass of pollen grains (Plate 5.2., fig. 4,5)

Different kinds of ectexine were compressed. Fig. 4, in plate 5.2., illustrates a damaged ectexine: the illustrated wall remnant may be the damaged tectum of the pollen grains. On the surfaces there are electron dense globular units. A relative well preserved, and compressed ectexine is illustrated in picture 5. Tectum with spinae, the infratectal layer is columellar. The foot layer of the two opposite ectexine are compressed. Characteristic lamellar embedding material is more or less connected to the surfaces.

6. Block: M-69-5 (Plate 5.3., fig. 1), similar to the previous ultrastructure illustrated in picture 4, plate 5.2.

7. Block: M-69-6, mass of compressed pollen or spore wall or disintegrated ectexine (Plate 5.3., fig. 2)

More or less homogeneous wall remnants were observed with electron dense superficial globular units.

8. Block: M-69-8. Fragments of small *cupuliferoid* ectexines. The tectum was partially preserved. There are lamellar embedding organic material on the surfaces (Plate 5.3., fig. 3).

9. Block: M-70-1 (Plate 5.3., fig. 4). *Cupuliferoid* ectexine, the tectum, the damaged infratectal layer and the foot layer are illustrated.

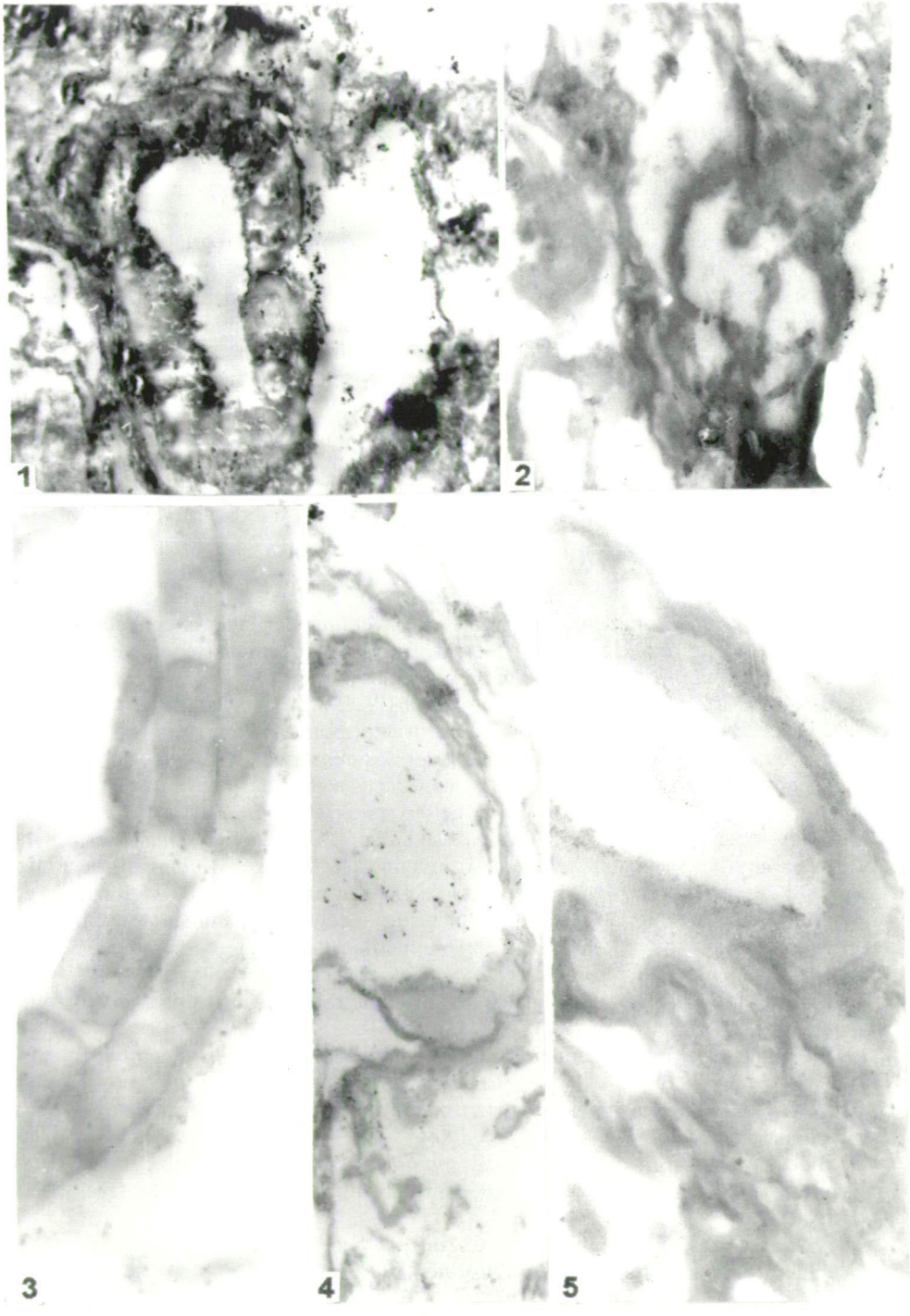


Plate 5.1.

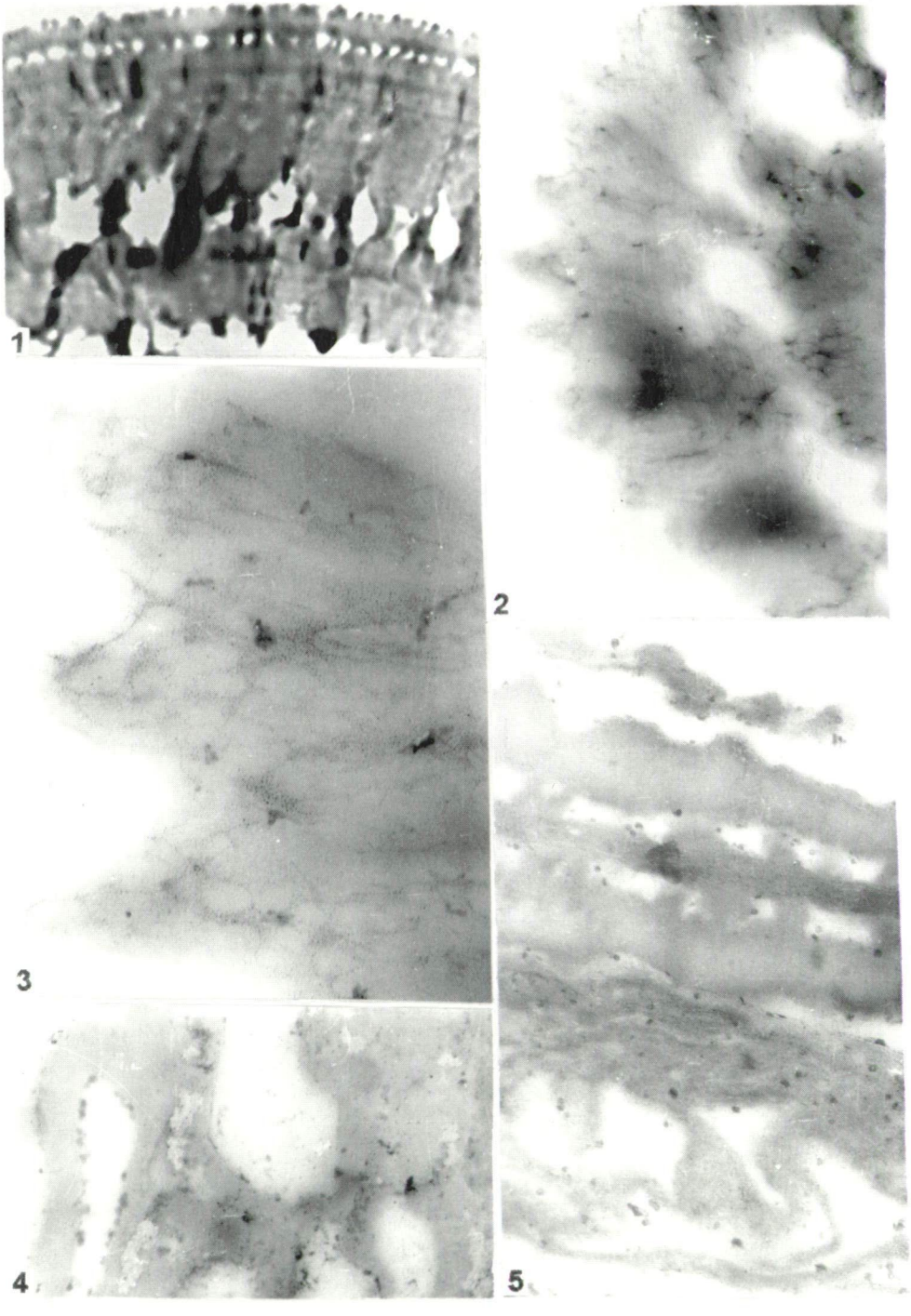


Plate 5.2.

Plate 5.1.

1-2. Block number: M-69-3, cf. *Cupuliferoidaepollenites quisqualis* (POTONIÉ 1934) POTONIÉ 1960, *Fagaceae* or *Leguminosae*. 1. Negative number: 7978, 5.000x, 2. Negative number: 7985, 15.000x.
3,4. Block number: M-69-1, cf. *Cupuliferoidaepollenites quisqualis* (POTONIÉ 1934) POTONIÉ 1960, *Fagaceae* or *Leguminosae*. 3. Negative number: 7592, 50.000x, 4. Negative number: 7596, 15.000x.
5. Block number: M-69-2, cf. *Triporopollenites* fsp. Negative number: 7600, 50.000x.

Plate 5.2.

1. Block number: M-70-4, cf. Classoidites fsp. Negative number: 7663, 5.000x.
2,3. Block number: M-70-2, Echinate *Brevaxones*. 2. Negative number: 7652, 15.000x, 3. Negative number: 7653, 50.000x.
4,5. Block number: M-69-4, 4. Negative number: 7610, 50.000x, 5. Negative number: 7619, 50.000x.

---

10. Block: M-70-3 (Plate 5.3., fig. 5). General survey picture of a heavily disintegrated organic material, with a remnant of ectexine. The lamellar embedding material is also damaged.

11. Block: M-70-12 (Plate 5.3., fig. 6). Compressed and damaged probably angiosperm ectexinous remnants, organic material is more or less closely connected to the outer part of the wall.

12. Block: M-70-21 (Plate 5.4., fig. 1) Homogeneous wall remnant probably of small spore origin.

13. Block: M-70-5 (Plate 5.4., figs. 2,3). Probably a perispore bearing microspore. An inner more or less homogeneous thick wall, a cavea, and a differentiated outer wall composed of an outer homogeneous perforated wall, followed with a globular or irregular inner part are shown. This layer may be a perispore. But other kind of origin of this unusual ultrastructure remnant is also possible.

14. Block: M-70-16 (Plate 5.4., fig. 4). Heavily damaged organic material with remnants of ectexine of *Longaxones* pollen grains.

16. Secondary xylem remnants: Blocks: M-69-7, M-69-10, M-70-19 (Plate 5.4., figs. 5-7). More or less well preserved lamellar ultrastructure of the secondary wall are illustrated in pictures 5,6, plate 5.4. Fossil resin drops are illustrated in picture 7, they are in all probability of *gymnosperm* (*taxodiaceous*) woody remnants.

Plate 5.3.

1. Block number: M-69-5, negative number: 7623, 50.000x.
2. Block number: M-69-6, negative number: 7629, 15.000x.
3. Block number: M-69-8, negative number: 7987, 15.000x.
4. Block number: M-70-1, negative number: 7641, 50.000x.
5. Block number: M-70-3, negative number: 7657, 5.000x.
6. Block number: M-70-12, negative number: 7812, 15.000x.

Plate 5.4.

1. Block number: M-70-21, negative number: 7822, 15.000x.
2,3. Block number: M-70-5, 2. Negative number: 7668, 5.000x, 3. Negative number: 7670, 50.000x.
4. Block number: M-70-16, negative number: 7740, 5.000x.
5. Block number: M-69-7, negative number: 7631, 15.000x.
6. Block number: M-69-10, negative number: 7636, 50.000x.
7. Block number: M-70-19, negative number: 7818, 15.000x.

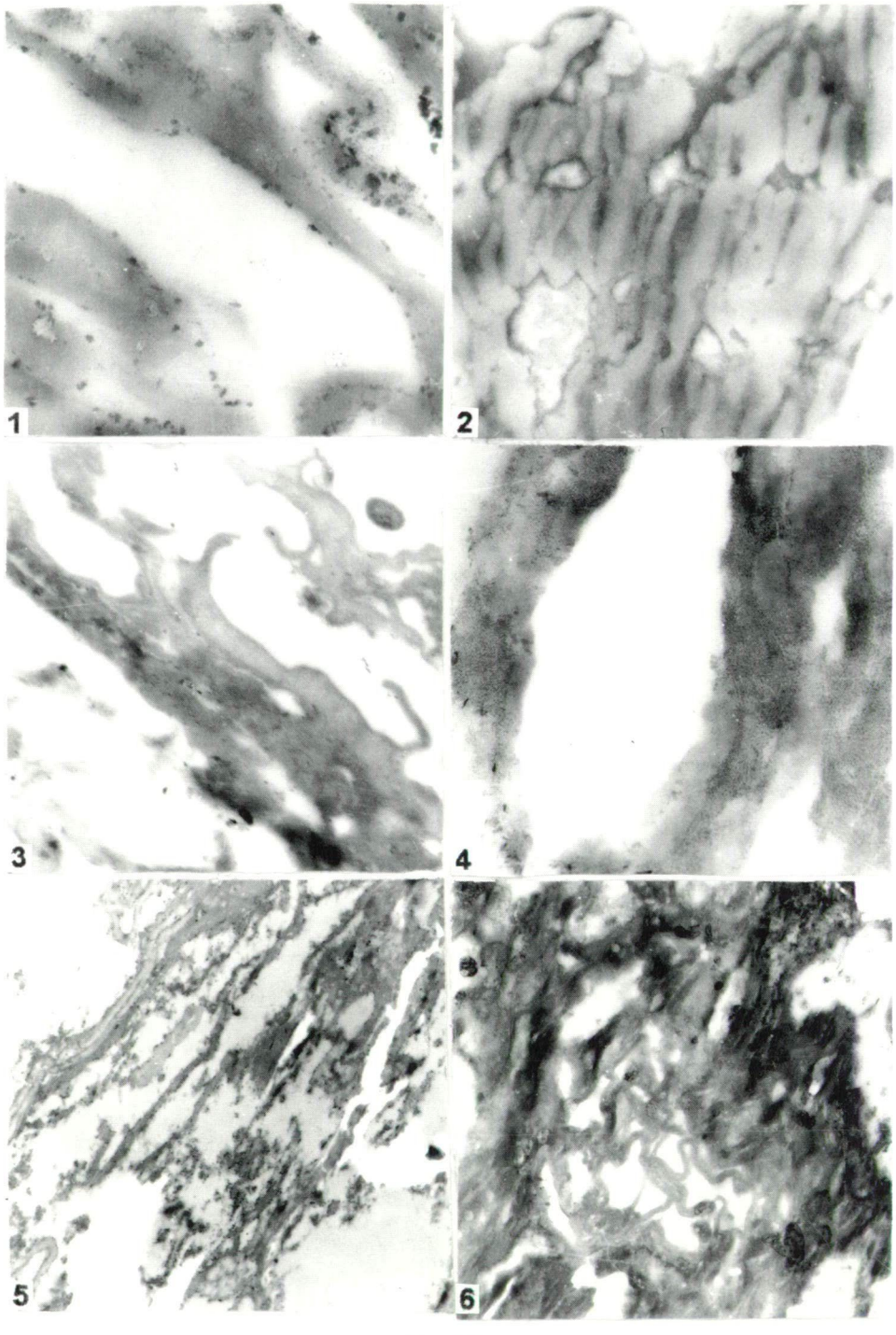


Plate 5.3.

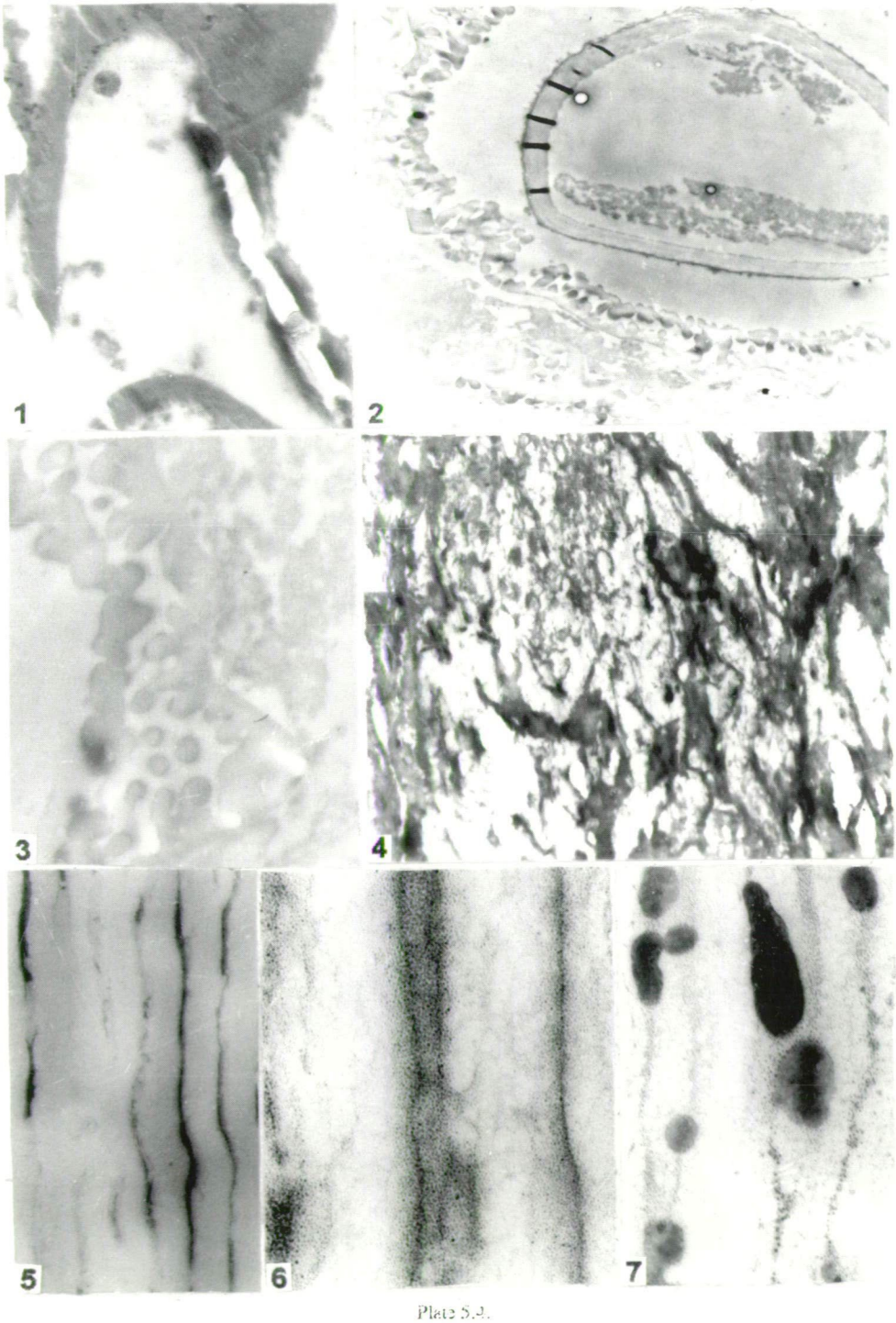


Plate S.9.

Discussion and Conclusions

1. This kind of experiments damaged heavily the ultrastructure of the pollen grains. In some cases the embedding material was disintegrated. In this way the taphonomical processes during the sedimentation is also an important factor of the ultrastructure preservation.

2. To discover the biopolymer system of the fossil pollen grains it seems that the oxidizing components, in the first place the $KMnO_4$, but the 2-aminoethanol also must be omitted.

3. The observed secondary woody remnants are similar to the previously published ones, cf. KEDVES and PÁRDUTZ (2000), p. 100, fig. 3, p. 103, fig. 3) from *Sequoioxylon gypsaceum* (GÖPPERT) GREGUSS 1967.

Acknowledgements

This work was supported by Grant A.K.P. PFP 1600-54.

References

GREGUSS, P. (1967): Fossil Gymnosperm Woods in Hungary from the Permian to the Pliocene. - Akadémiai Kiadó, Budapest.

KEDVES, M. and MADARÁSZ, M. (2000): Transmission electron microscopy of the partially degraded pollen grains from the Thanetian layers of Menat (France) I. - Plant Cell Biology and Development (Szeged) *12*, 40-62.

KEDVES M. and PÁRDUTZ, Á. (2000): Transmission electron microscopy of Hungarian Tertiary lignites II. - Plant Cell Biology and Development (Szeged) *11*, 99-106.

6. LM, SEM AND TEM INVESTIGATIONS ON PARTIALLY DEGRADED BOTRYOCOCCUS BRAUNII KÜTZ. COLONIES FROM HUNGARIAN UPPER TERTIARY OIL SHALE II.

M. KEDVES[1], Á. PÁRDUTZ[2], K. PRISKIN[1], A. SZÉCSÉNYI[1], J., SASHALMI[1], D. TOMBÁCZ[1] and A. BORBOLA[1]

1. Cell Biological and Evolutionary Micropaleontological Laboratory of the University of Szeged, H-6701, P.O. Box 993, Szeged, Hungary, 2. Institute of Biophysics, Biological Research Center of the Hungarian Academy of Sciences, H-6701, P.O. Box 521, Szeged, Hungary

Abstract

The new experiments are the methodological continuation of the previously published ones.The length of time of the degradation with 2-aminoethanol was 4, 5 and 6 days, but the oxidation with $KMnO_4$ and the dissolution with merkaptoethanol remained of 24 hours. In this way the most moderate degradation in this new series was stronger than the strongest degradation of the previous series of experiment. The new LM, TEM and SEM data indicated also this strong degradation. The SEM results of the degradation with 2-aminoethanol and the oxydation with $KMnO_4$ resulted in superficial globular biopolymer units. The diameter of these units is 40-400 Å, much larger than that of discovered by the previous experiments. The TEM method indicated the degradation of the quasi-periodic and quasi-equivalent biopolymer structures. These new results confirmed, that for the biopolymer symmetry operations the experiments No. AKP-99-4,5,7,8 published in the previous publication are the most suitable.

Key words: Alginite, partial degradation, LM, SEM, TEM.

Introduction

In our previous work (KEDVES et al., 2000) an attempt was made to survey the most important papers concerning the structure, chemistry, and EM results of *Botryococcus braunii* KÜTZ. colonies. Particular attention was made to the Hungarian Upper Pannonian oil shale. The partially degraded colonies by different kinds of methods were investigated with the LM, SEM and TEM methods. To continue this series of experiments stronger partial degradations were carried out.

The aim of this paper is to establish more suitable experiments for the symmetry operations of the different biopolymer and /or molecular structures. Taking into consideration the pecularities in the biopolymer symmetry of the *Botryococcus braunii*, cf. e.g.: KEDVES, ROJIK and VÉR, (1991), KEDVES, TRIPATHI, VÉR, PÁRDUTZ and ROJIK, (1998), there are a lot of problem to solve.

Materials and Methods

The temperature for each experiment was 30 °C.
AKP-99-10. - 3 mg *Botryococcus* colony + 1 ml 2-aminoethanol, length of time 96 h.
AKP-99-11. - 3 mg *Botryococcus* colony + 1 ml 2-aminoethanol, length of time 120 h.
AKP-99-12. - 3 mg *Botryococcus* colony + 1 ml 2-aminoethanol, length of time 144 h.
AKP-99-13. - 3 mg *Botryococcus* colony + 1 ml 2-aminoethanol, length of time 96 h, after washing + 10 ml $KMnO_4$ 1%, length of time 24 h.
AKP-99-14. - 3 mg *Botryococcus* colony + 1 ml 2-aminoethanol, length of time 120 h, after washing + 10 ml $KMnO_4$ 1%, length of time 24 h.
AKP-99-15. - 3 mg *Botryococcus* colony + 1 ml 2-aminoethanol, length of time 144 h, after washing + 10 ml $KMnO_4$ 1%, length of time 24 h.
AKP-99-16. - 3 mg *Botryococcus* colony + 1 ml 2-aminoethanol, length of time 96 h, after washing + 1 ml merkaptoethanol, length of time 24 h.
AKP-99-17. - 3 mg *Botryococcus* colony + 1 ml 2-aminoethanol, length of time 120 h, after washing + 1 ml merkaptoethanol, length of time 24 h.
AKP-99-18. - 3 mg *Botryococcus* colony + 1 ml 2-aminoethanol, length of time 144 h, after washing + 1 ml merkaptoethanol, length of time 24 h.

After partial degradation the used LM, SEM and TEM methods are completely identical with the previous ones (KEDVES et al., 2000, p. 67).

Results

1. LM results

Experiments AKP-99-10-12 (Plate 6.1., figs. 1-3)

The partial dissolution with 2-aminoethanol during 4-5-6 days resulted characteristic alterations. Moderate degradation of the wall, and dark amorphous content, probably kerogen appeared in the cups (Plate 6.1., figs. 1-3).

Experiments AKP-99-13-15 (Plate 6.1., figs. 4-6)

After partial degradation and oxidation with $KMnO_4$ the inner part of the colonies turned into very dark. The outest part of the cups of the colonies remained lighter. At this part of the colonies remarkable disintegration was also observed.

Experiments AKP-99-16-18 (Plate 6.1., figs. 16-18)

The effect of the merkaptoethanol after 2-aminoethanol was also perceptible at the first series of experiments (p. 71, in KEDVES et al., 2000). This degradation process is more expressed after the longer treatement with 2-aminoethanol.

2. EM results

Experiment: AKP-99-10

SEM pictures (Plate 6.2., figs. 1,2) illustrate superficial degradation. Debris and small globular biopolymer units on the surface were observed only occasionally. Autospores are well illustrated in the low magnified picture (Plate 6.2., fig. 1). The preservation of the autospores is better than the cups of the colonies. The TEM pictures (Plate 6.4., figs. 1,2) illustrate the degradation of the cups, but there are electron dense granular units within the wall. The ultrastructure of the inner content of the cups is well shown, there are tiny dark globular or linear units in the more or less homogeneous substance.

Experiment: AKP-99-11

The low magnified SEM picture illustrates well the differences in the preservation and in this way the differences in the measure of the degradation of the different colonies (Plate 6.2., fig. 3). In the highly magnified picture (Plate 6.2., fig. 4) the different kinds of debris are shown on the surface. There are globular units within these cellular debris. It is probable that the outest lamella of the cup was destroyed, and the remnants of this layer are perceptible on the surface of an inner lamella. The degradation of the wall is well shown in the TEM pictures (Plate 6.4., figs. 3,4), too. There are globular electron dense particles in the more or less homogeneous wall.

Experiment: AKP-99-12

The SEM results are essentially identical with the previous experiment (Plate 6.2., figs. 5,6). A very well preserved diatom remnant of Pennatae type was observed in this sample (Plate 6.3.). Dr. M. HAJÓS was asked for the nearer determination for this algue, she accepted our request, but she is very ill so we publish this remnant without nearer determination. The TEM investigations (Plate 6.4., 5-7) in contrast to the previous experiment resulted characteristic lamellar structures in the wall of the cups. The lamellae are bordered by electron dense inner surfaces. Sometimes the inner lamella is separated from the others (Plate 6.4., figs. 5,6). There are organic remnants in the cups (Plate 6.4., fig. 5).

Experiment: AKP-99-13

The SEM pictures (Plate 6.5., figs. 1,2) illustrate well the remarkable degradation of the wall. The superficial globular units are well shown in the highly magnified picture (Plate 6.4., fig. 2). The distribution of the diameters of the globular units are as follows:

40	80	120	160	200	240	280	320	360	400	Å
22.7	34.0	26.2	10.1	3.9	1.6	0.8	0.5	0.1	0.1	%

Plate 6.1.

1-9. *Botryococcus braunii* KÜTZ. LM pictures. 1. - Experiment number: AKP-99-10, 2. - Experiment number: AKP-99-11, 3. -AKP-99-12, 4.-AKP-99-13, 5.-AKP-99-14, 6.-AKP-99-15, 7.-AKP-99-16, 8.-AKP-99-17, 9.-AKP-99-18. Magnification: 670x.

Plate 6.2.

1-7. *Botryococcus braunii* KÜTZ. SEM pictures. 1,2. - Experiment number: AKP-99-10, 3,4.-AKP-99-11, 5,6,7.-AKP-99-12.

Plate 6.3.

SEM picture of a diatom of Pennatae type.

Plate 6.4.

1-7. Ultrastructure of the partially degraded colonies of *Botryococcus braunii* KÜTZ. 1,2. - Experiment number: AKP-99-10, 1. Negative number: 7878, 5.000x., 2. Negative number: 7879, 15.000x., 3,4. - Experiment number: AKP-99-11, 3. Negative number: 7882, 15.000x., 4. Negative number: 7883, 50.000x., 5,6,7. - Experiment number: AKP-99-12, 5. Negative number: 7889, 5.000x., 6. Negative number: 7886, 15.000x., 7. Negative number: 7887, 50.000x.

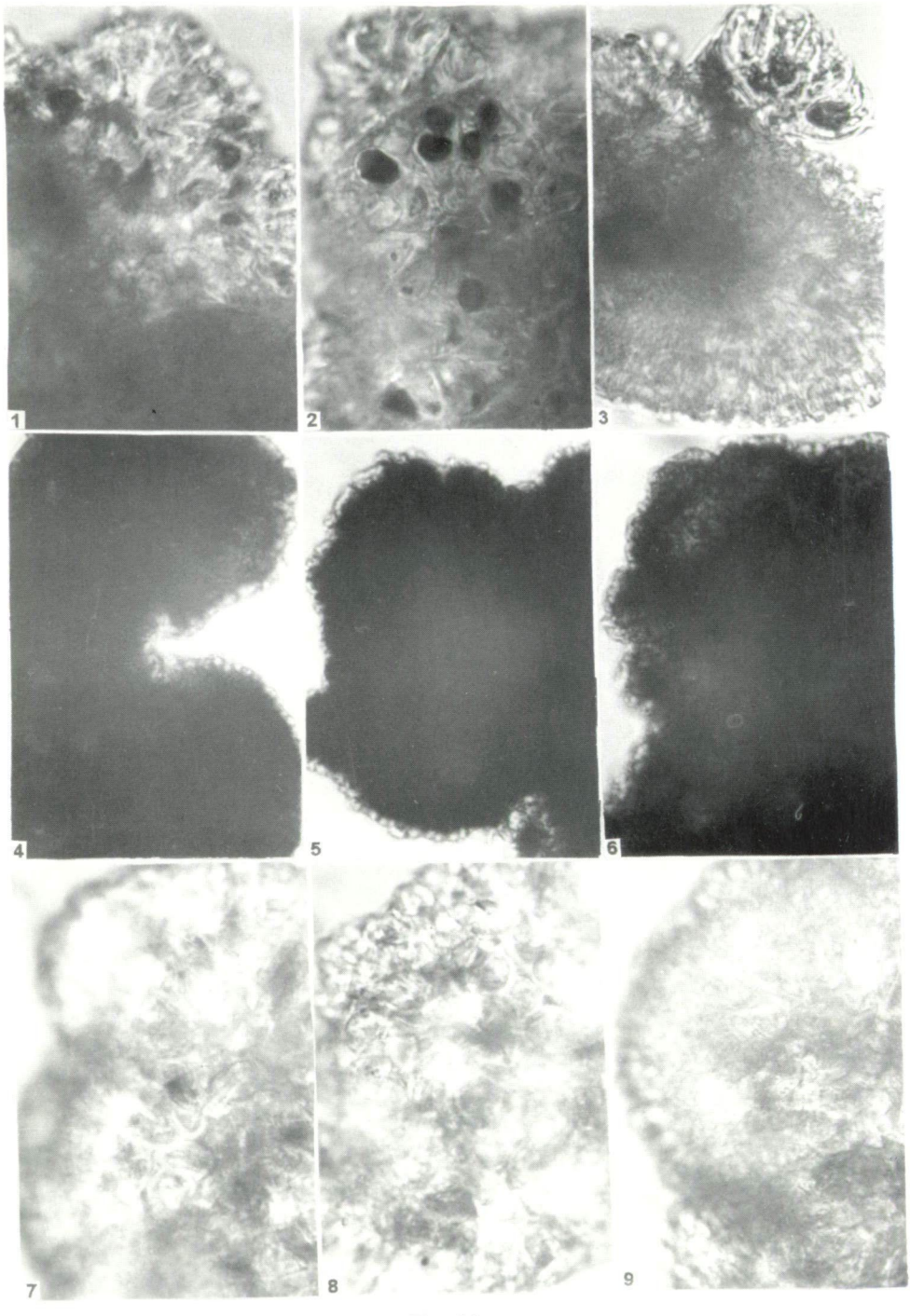


Plate 6.1.

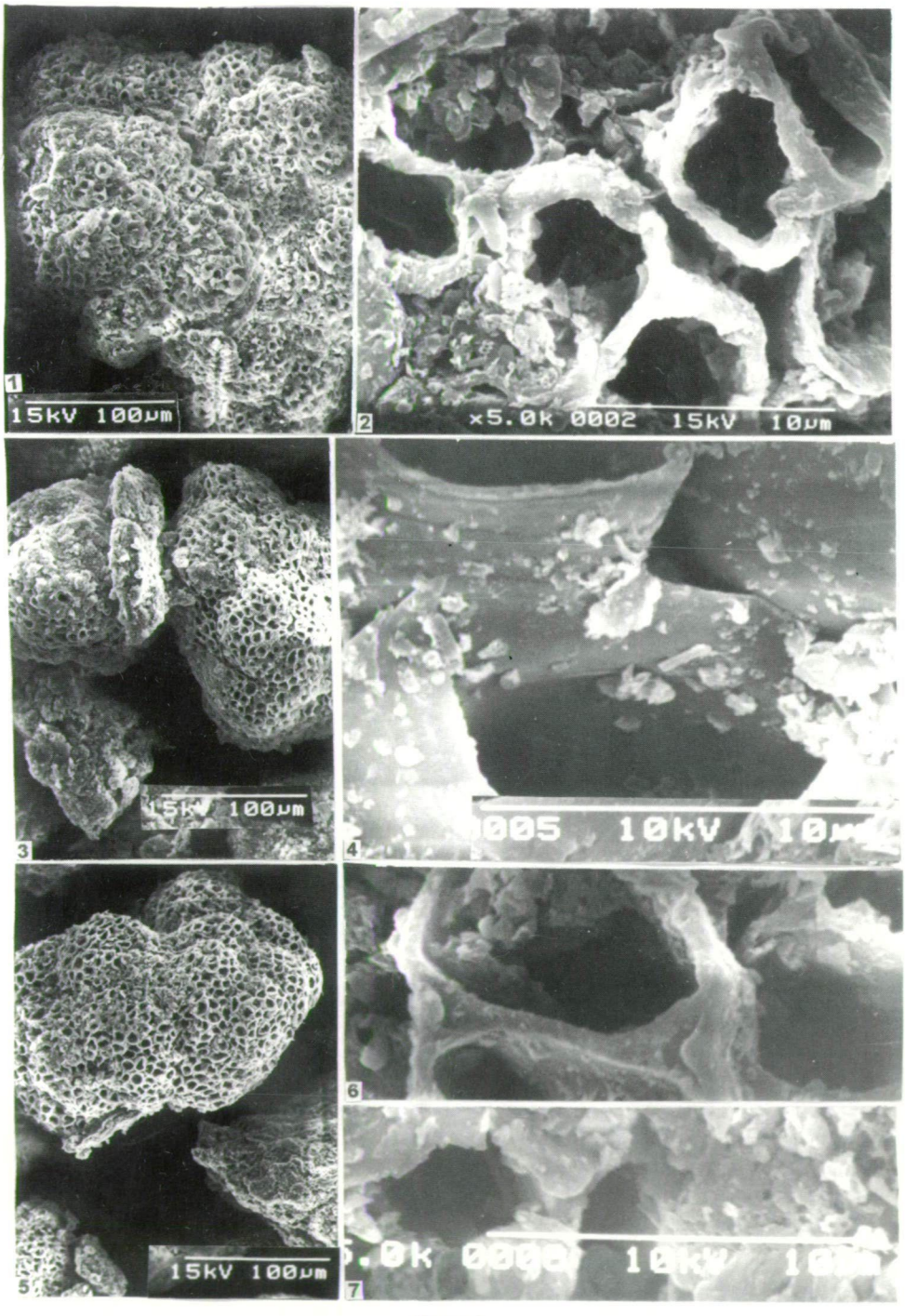

1
15kV 100µm
2
×5.0k 0002 15kV 10µm
3
15kV 100µm
4
10kV
5
15kV 100µm
6
7

Plate 6.2.

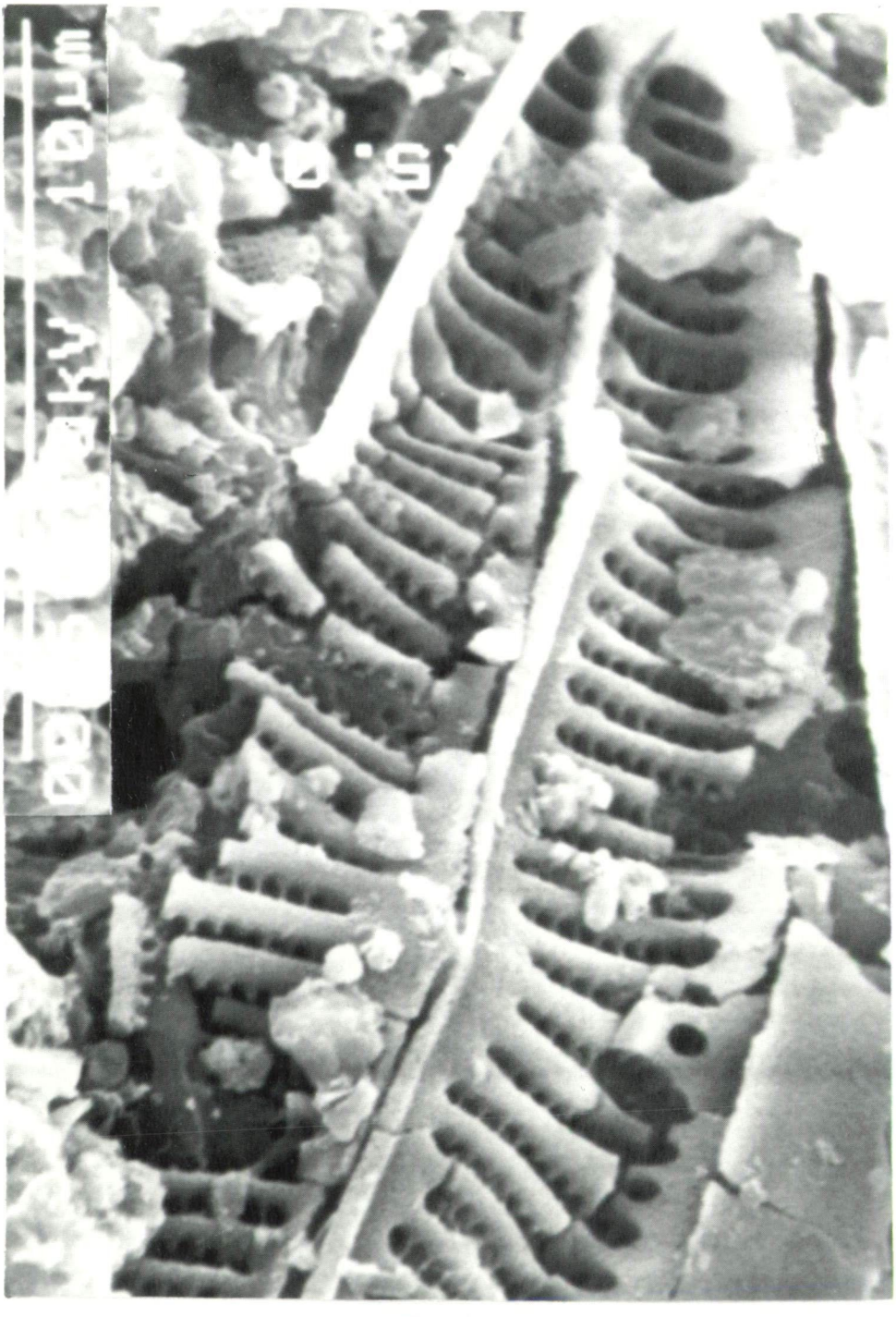


Plate 6.3.

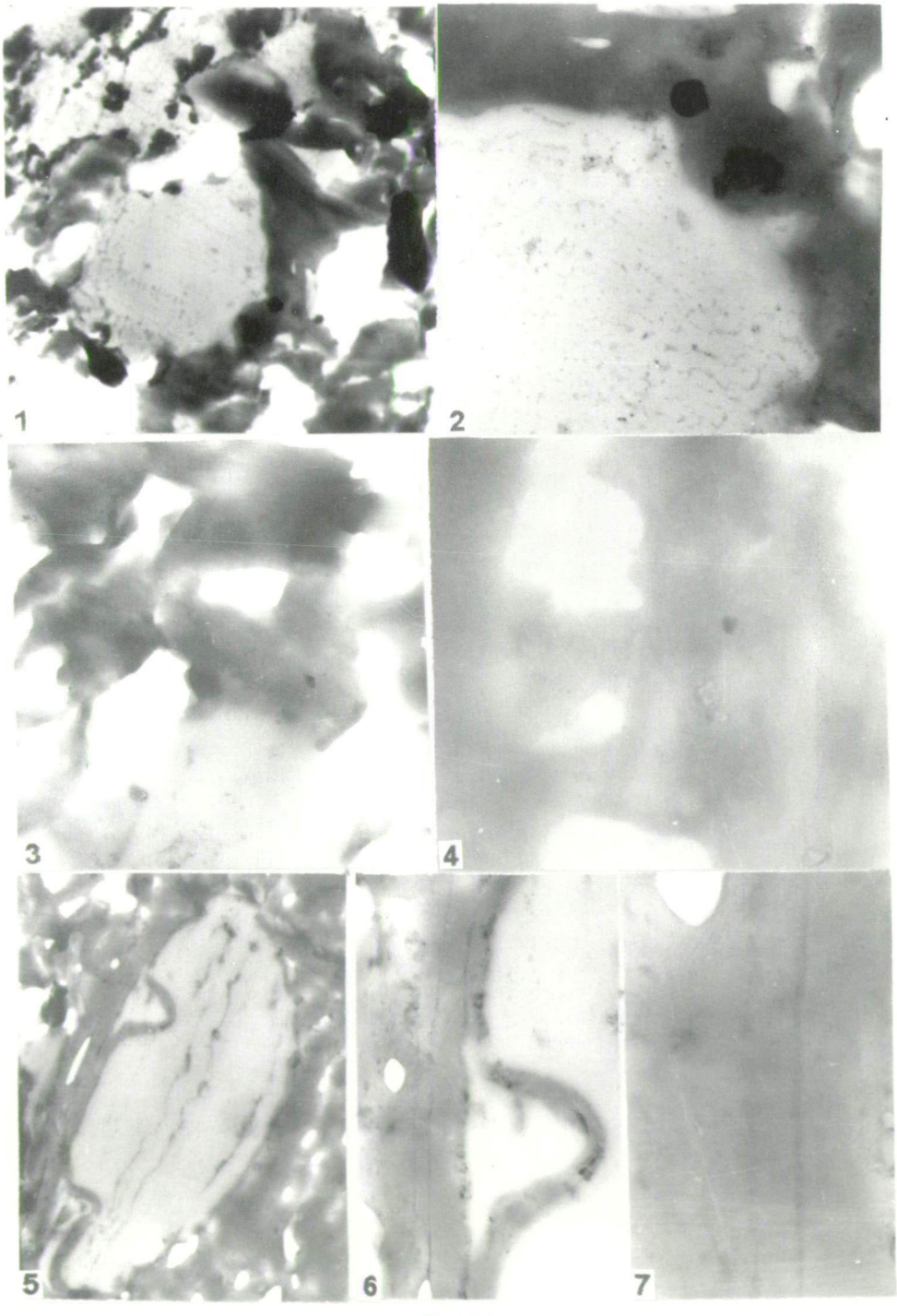


Plate 6.4.

The TEM pictures (Plate 6.6., figs. 1,2) illustrate the advanced degradation of the ultrastructure of the wall, but damaged lamellae are perceptible in particular in the low magnified picture (Plate 6.6., fig. 1).

Experiment: AKP-99-14

Based on the SEM pictures (Plate 6.5., figs. 3-5) this experiment revealed the globular biopolymer structures better than at the previous one. The distribution of the globular superficial units are as follows:

40	80	120	160	200	240	280	320	Å
17.5	36.1	26.3	12.2	4.7	2.3	0.4	0.5	%

The ultrastructure is severely damaged (Plate 6.6., figs. 3,4), sometimes less characteristic electron dense particles are in the substance of the wall.

Experiment: AKP-99-15

The SEM (Plate 6.5., figs. 6-8) and the TEM results (Plate 6.6., figs. 5,6) are essentially identical with those of the previous experiment. The distribution of the diameter of the globular biopolymer units are as follows:

40	80	120	160	200	240	280	320	360	Å
19.6	33.6	27.8	2.0	5.0	1.2	0.4	-	0.4	%

Experiment: AKP-99-16

Characteristic superficial degradation was observed in the SEM pictures (Plate 6.7., figs. 1,2) but the globular biopolymer units are not so well revealed, and are not suitable for statistical investigations. The TEM pictures (Plate 6.8., figs. 1,2) illustrate a very damaged wall structure. This may be the consequence of an individual characteristic feature.

Plate 6.5.

1-8. *Botryococcus braunii* KÜTZ. SEM pictures. 1,2. - Experiment number: AKP-99-13, 3,4,5. - Experiment number: AKP-99-14, 6,7,8. - Experiment number: AKP-99-15.

Plate 6.6.

1-6. Ultrastructure of the partially degraded colonies of *Botryococcus braunii* KÜTZ. 1,2. -Experiment number: AKP-99-13, 1. Negative number: 7890, 50.000x., 2. Negative number: 7889, 50.000x., 3,4. - Experiment number: AKP-99-14, 3. Negative number: 7891, 5.000x., 4. Negative number: 7892, 15.000x., 5,6. - Experiment number: AKP-99-15, 5. Negative number: 7896, 15.000x., 6. Negative number: 7897, 50.000x.

Plate 6.7.

1-6. *Botryococcus braunii* KÜTZ. SEM pictures. 1,2. - Experiment number: AKP-99-16, 3,4. - Experiment number: AKP-99-17, 5,6. - Experiment number: AKP-99-18.

Plate 6.8.

Ultrastructure of the partially degraded colonies of *Botryococcus braunii* KÜTZ. 1,2. -Experiment number: AKP-99-16, 1. Negative number: 7924, 15.000x., 3,4. - Experiment number: AKP-99-17, 3. Negative number: 7927, 15.000x., 4. Negative number: 7928, 50.000x., 5,6. - Experiment number: AKP-99-18, 5. Negative number: 7930, 15.000x., 6. Negative number: 7932, 50.000x.

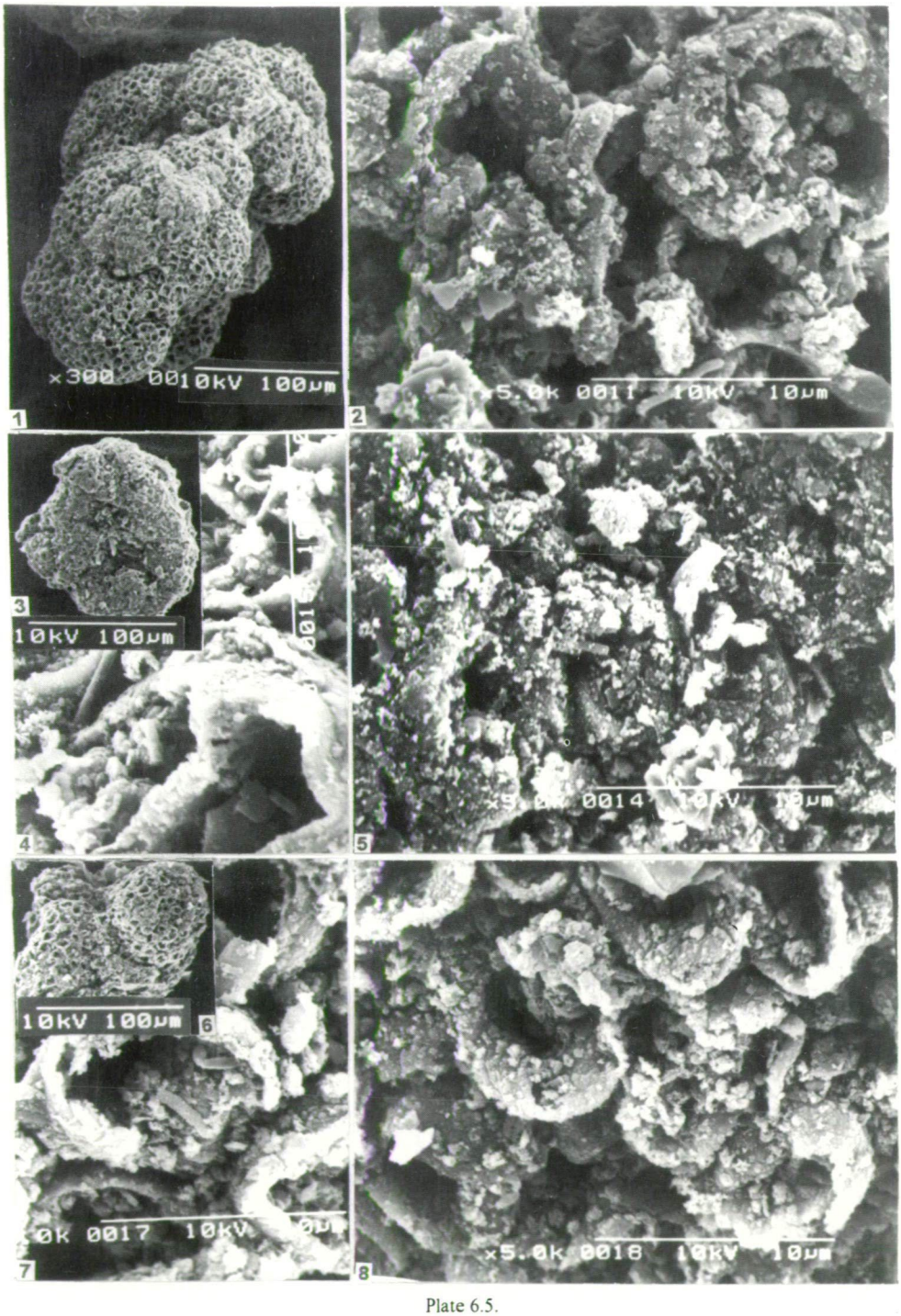

1
×300 001 10kV 100µm
2
5.0k 0011 10kV 10µm
3
10kV 100µm
4
5
6
10kV 100µm
7
0k 0017 10kV
8
×5.0k 0018 10kV 10µm

Plate 6.5.

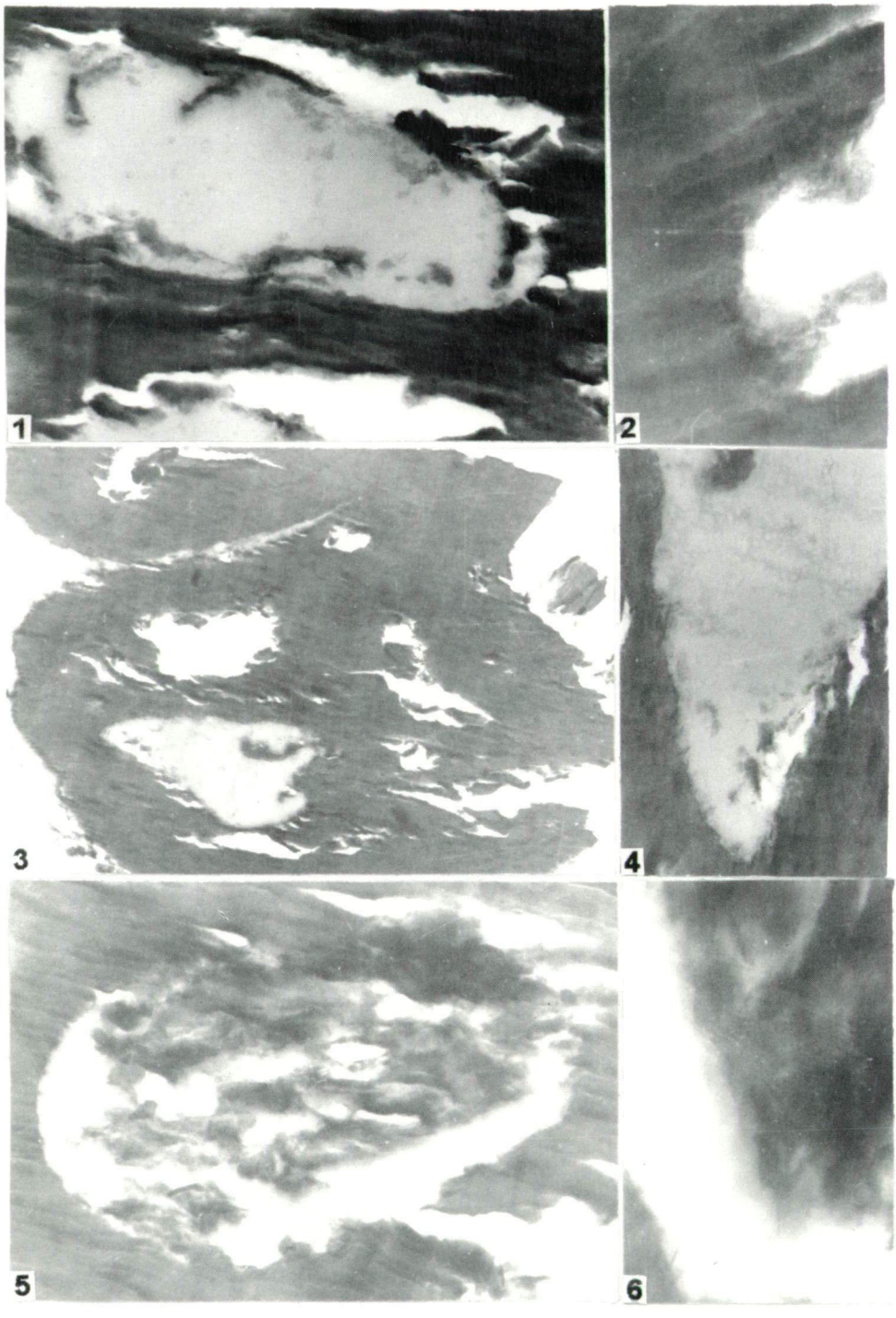


Plate 6.6.

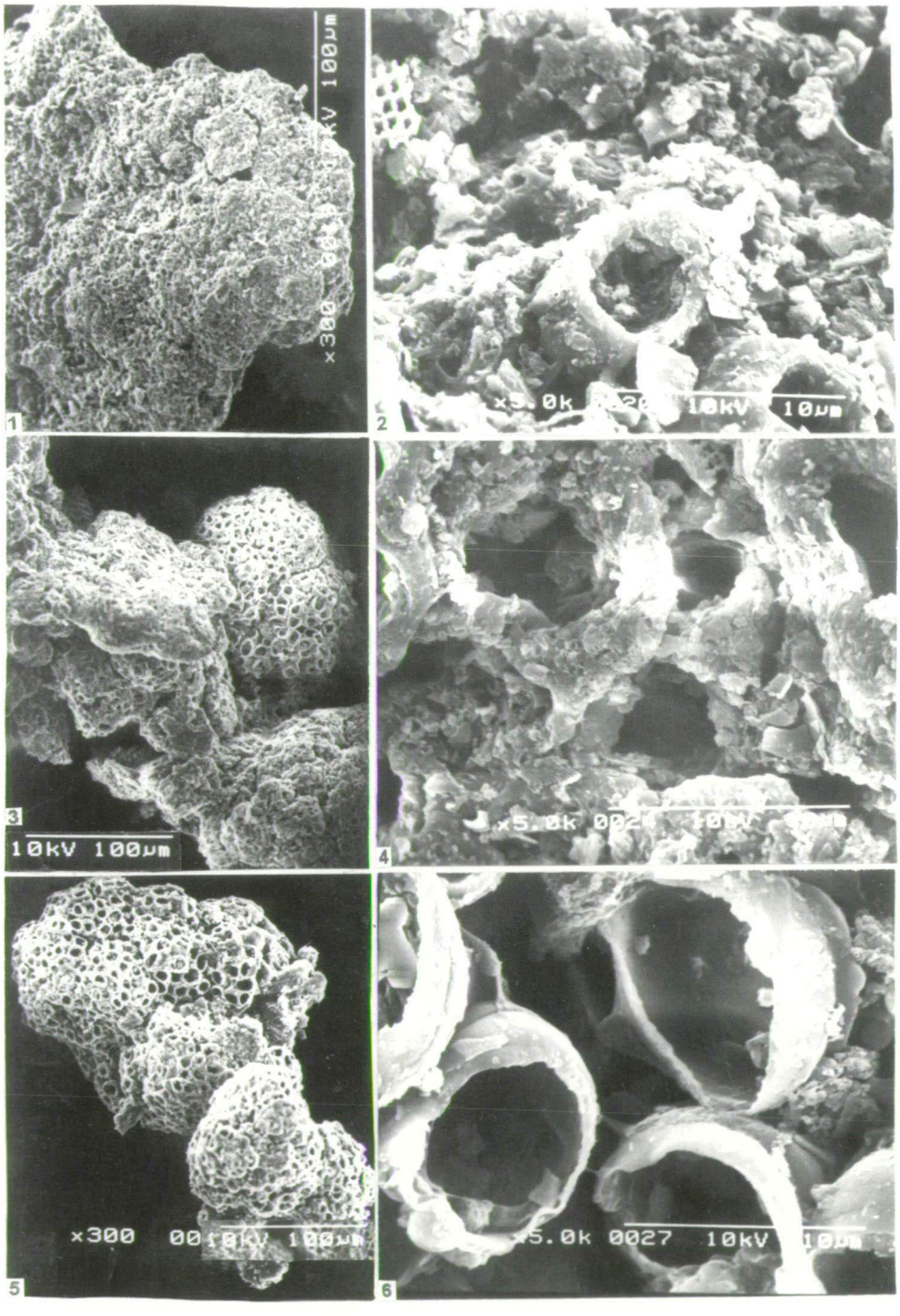


Plate 6.7.

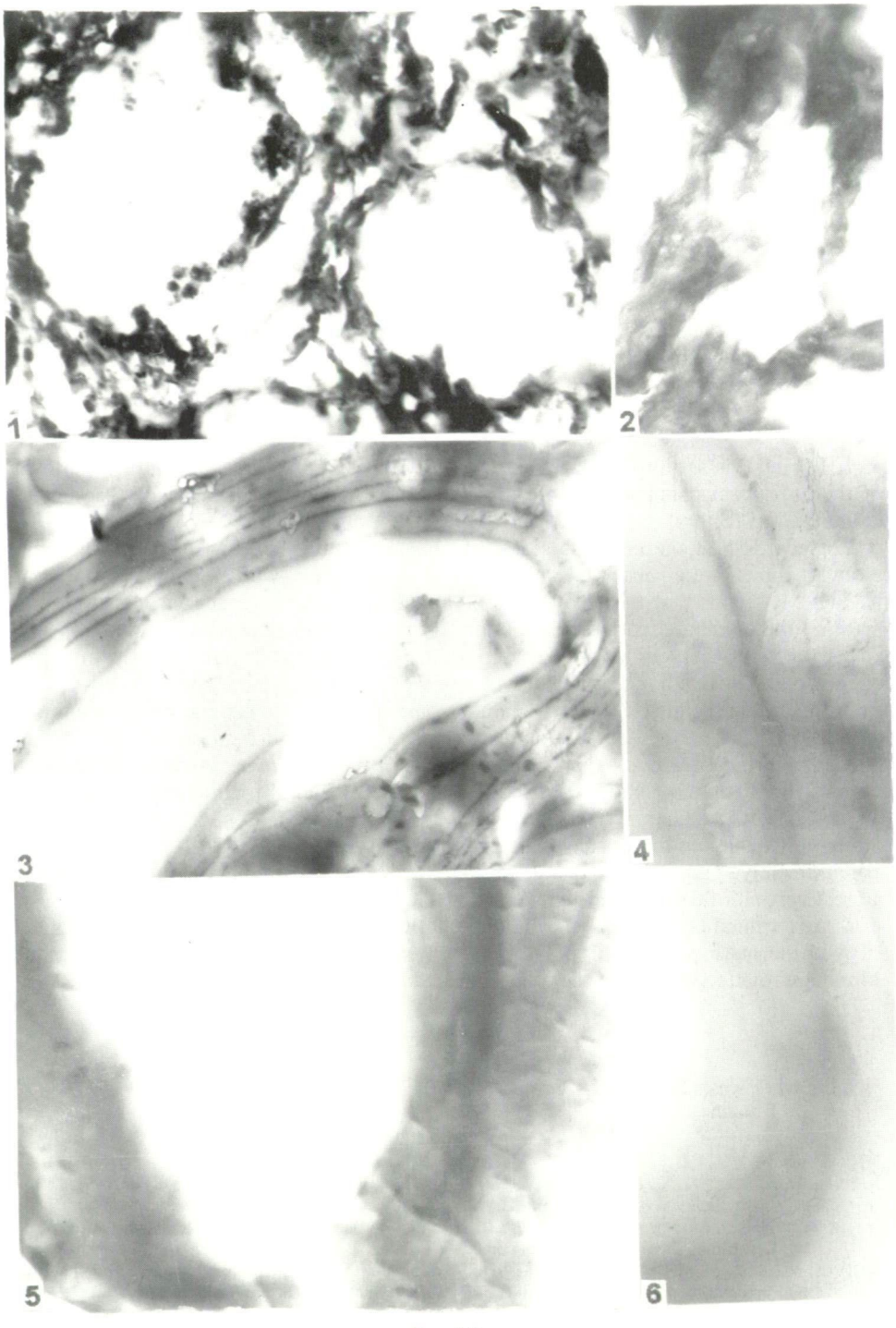


Plate 6.8.

Experiment: AKP-99-17

The SEM results are essentially identical with the previous one (Plate 6.7., figs. 3,4). The different kind of preservation is well illustrated in the picture 3, in Plate 6.7.

It is interesting that the TEM method resulted characteristic lamellar ultrastructure of the wall (Plate 6.8., figs. 3,4). Electron dense globular particles are well shown in the substance of the cups.

Experiment: AKP-99-18

In contrast to the previous experiments the surface is more or less smooth, globular units are very rare, particularly on the damaged parts of the colony (Plate 6.7., figs. 5,6). It may presumed that the superficial partially degraded layer was destroyed. The TEM pictures (Plate 6.8., figs. 5,6) support this supposition. The lamellar ultrastructure is not so characteristic, the surfaces are severely damaged.

Discussion and Conclusions

1. During this series of experiments we have observed several times the importance of the individual characteristic of the colonies, e.g.: ontogenetical stage, ecological, taphonomical factors.

2. According to the previous series of experiments by the SEM method superficial globular units were observed after partial degradation with 2-aminoethanol, and $KMnO_4$. It seems, that to discover the biopolymer system of recent and fossil organic material the combined partial degradation, namely 2-aminoethanol and $KMnO_4$ is suitable. But it is necessary to emphasize, that there are several exceptions also in consequence of the different molecular structure of the investigated biopolymer structures.

3. Regarding the diameter of the globular superficial units in general we can establish, that this stronger partial degradation discovered larger units than previously. In our classification in our previous paper, p. 82, was the largest globular structures of diameter more than 130 Å. The diameter of the partially degraded and fragmented colonies was about 224-240 Å. In this way the present experiments (AKP-99-13,14,15) discovered the largest units, but the greatest part of the units is between 40-120 Å. These units are approximately comparable to the data of AKP-99-6, with the remark that the diameter of a great percent of the globular units is 20 and 30 Å.

4. As terminal conclusion we can point out that these strongest partial degradation destroyed the quasi-periodic biopolymer system which can be studied with the modified Markham rotation method of the ultrathin sections.

Acknowledgements

This work was supported by Grant A.K.P. PFP 1600-54.

References

KEDVES, M., PÁRDUTZ, Á., MADARÁSZ, M., TOMBÁCZ, D., HORVÁTH, A., SZÉCSÉNYI, A., SASHALMI, J., TERBE, ZS., HORVÁTH, ESZTER, and KOVÁCS, E. (2000): LM, SEM and TEM investigations on partially degraded *Botryococcus braunii* KÜTZ. colonies from Hungarian Upper Tertiary oil shale I. - Plant Cell Biology and Development (Szeged) *12*, 63-86.

KEDVES, M., ROJIK, I. and VÉR, A. (1991): Biopolymer organization of the partially degraded oil shale with the fragmentation method. - Plant Cell Biology and Development (Szeged) *1*, 28-31.

KEDVES, M., TRIPATHI, S.K.M., VÉR, A., PÁRDUTZ, Á. and ROJIK, I. (1998): Experimental studies on *Botryococcus* colonies from Hungarian Upper Tertiary oil shale. - Plant Cell Biology and Development (Szeged) *9*, 43-63.

7. LM AND SEM INVESTIGATIONS ON PARTIALLY DISSOLVED ALLERGEN POLLEN GRAINS I.

M. KEDVES[1], Á. PÁRDUTZ[2], A. SZÉCSÉNYI[1], K. PRISKIN[1], M. MADARÁSZ[1], D. TOMBÁCZ[1], J. SASHALMI[1] and A. HORVÁTH[1]

1. Cell Biological and Evolutionary Micropaleontological Laboratory of the University of Szeged, H-6701, P.O. Box 993, Szeged, Hungary, 2. Institute of Biophysics, Biological Research Center of the Hungarian Academy of Sciences, H-6701, P.O. Box 521, Szeged, Hungary

Abstract

Pollen grains of *Tilia cordata* MILL. were partially dissolved with 2-aminoethanol for 30 minutes, 1 hour, 5, 10 and 24 hours, and investigated with the LM and the SEM method. Alterations in the LM morphology and the fine sculpture of the surface were analyzed and compared with the previous results. After 24 hours of treatment remarkable alterations were established by the LM and the SEM methods.

Key words: Palynology, recent, *Tilia*, partial degradation, LM, SEM.

Introduction

The experimental study by different method on the pollen grains of *Tilia cordata* are included in the research program of our Laboratory. The earlier morphological characteristic features from evolutionary point of view of this kind of pollen grains was pointed out in several papers. On the other hand in case of the pollen grains of *Tilia platyphyllos* SCOP. it was established that the sporopollenin of the ectexine is easily soluble by diethylamine (KEDVES et al., 1998). Pollen grains of *Tilia cordata* were irradiated by KEDVES and KÁROSSY (1998) and a moderate pollen tube development in consequence of the X-ray irradiation was observed. Corroded *Tilia* exines by phase and differential interference contrast were published by ROWLEY, ROWLEY and SKVARLA (1990). The pollen grains of *Tilia* by the SEM data of SKVARLA, ROWLEY and CHISSOE (1996) does not seem to be corroded. Small irregular holes were observed on the tectum (Plate 6, fig. 1). The fractured foot layer of the *Tilia* shows several holes which may be corrosion sites. Corrosion was established at the base of the columellar infratectal layer also. The allergenic character of the pollen grains of the genus *Tilia* was pointed out in several works, e.g.: *Tilia cordata* by NILSSON, PRAGLOWSKI and NILSSON (1977) and RICHARD et al. (1986), *Tilia tomentosa* MOENCH. by PEHLIVAN (1995). LM, SEM and TEM data published by NILSSON, PRAGLOWSKI and NILSSON (1977) are very important for comparison with our data.

Taking into consideration the previous results, in particular the solubility of the ectexine with diethylamine pollen grains of the genus *Tilia* were also included in this research program.

Materials and Methods

Pollen grains of *Tilia cordata* MILL. were collected by Miss M. MADARÁSZ from Szeged (cultivated). The experiments are as follows: T-12-42, fresh pollen grains. During partial dissolution 1 ml 2-aminoethanol was added to 5 mg dry pollen material. Temperature 30 C°, length of times are as follows: 30 minutes (T-12-43), 1 hour (T-12-44), 5 hours (T-12-45), 10 hours (T-12-46), 24 hours (T-12-47). LM investigations were made on unstained pollen grains (a) and stained with methylviolet (b). For SEM investigations the dry pollen grains were covered with gold-palladium and investigated with a Hitachi S-2400 instrument (resolution about 40 Å) in the SEM Laboratory of the Department of Botany of the University of Szeged.

Results

LM results

Qualitative results

T-12-43 - T-12-46. (Plate 7.1. figs., 5,6, 10,11, plate 7.2., figs. 1,2, 6,7). By the LM method there are no important difference in the secondary alterations. The endannulus is characteristic and a plicate form appeared. The endannulus at the coloured pollen grains is characteristic. After 24 hours of dissolution (T-12-47, Plate 7.2., figs. 11,12) important alterations were observed. The endannulus is less characteristic, the exoaperture is ellipsoid pore like and the ornamentation is not well perceptible.

Quantitative results

Experiment number:	Size (µm, %)								Dominant size (µm):	Average: (µm)
	27.5	30	32.5	35	37.5	40	42.5	45		
T-12-42 a		8	**39**	**43.5**	9.5				32.5; 35	33.9
T-12-43 a		0.5	30	**47.5**	22				35	34.8
T-12-44 a	0.5	4.5	28	**51**	16				35	34.4
T-12-45 a		0.5	14	**65**	20.5				35	35.1
T-12-46 a		7	22.5	**34.5**	35	1			35; 37.5	35.02
T-12-47 a					28.5	**34.5**	**37**		40; 42.5	40.22
T-12-42 b		20.5	**63**	16.5					32.5	32.4
T-12-43 b		8	**48.5**	**39**	4.5				32.5; 35	33.5
T-12-44 b		11.5	**43.5**	**41**	4				32.5; 35	33.43
T-12-45 b		9.5	29	**42.5**	19				35	34.28
T-12-46 b	1	9.5	22.5	**40**	26	1			35	34.58
T-12-47 b				8.5	**41.5**	**39**	10.5	0.5	37.5; 40	38.83

SEM results (Plate 7.1., figs. 3,4, 7-9, 12,13, plate 7.2., figs. 3-5, 8-10, 13-15)

Plate 7.1.

1-13. Tilia cordata MILL.
1-4. Experiment No.: T-12-42. 1,2. LM pictures, 3,4. SEM pictures. 5-9. Experiment No.: T-12-43, 5,6. LM pictures, 7-9. SEM pictures. 10-13. Experiment No.: T-12-44. 10,11. LM pictures, 12,13. SEM pictures.

Plate 7.2.

1-15. Tilia cordata MILL.
1-5. Experiment No.: T-12-45. 1,2. LM pictures, 3-5. SEM pictures. 6-10. Experiment No.: T-12-46. 6,7. LM pictures, 8-10. SEM pictures. 11-15. Experiment No.: T-12-47. 11,12. LM pictures, 13-15. SEM pictures.

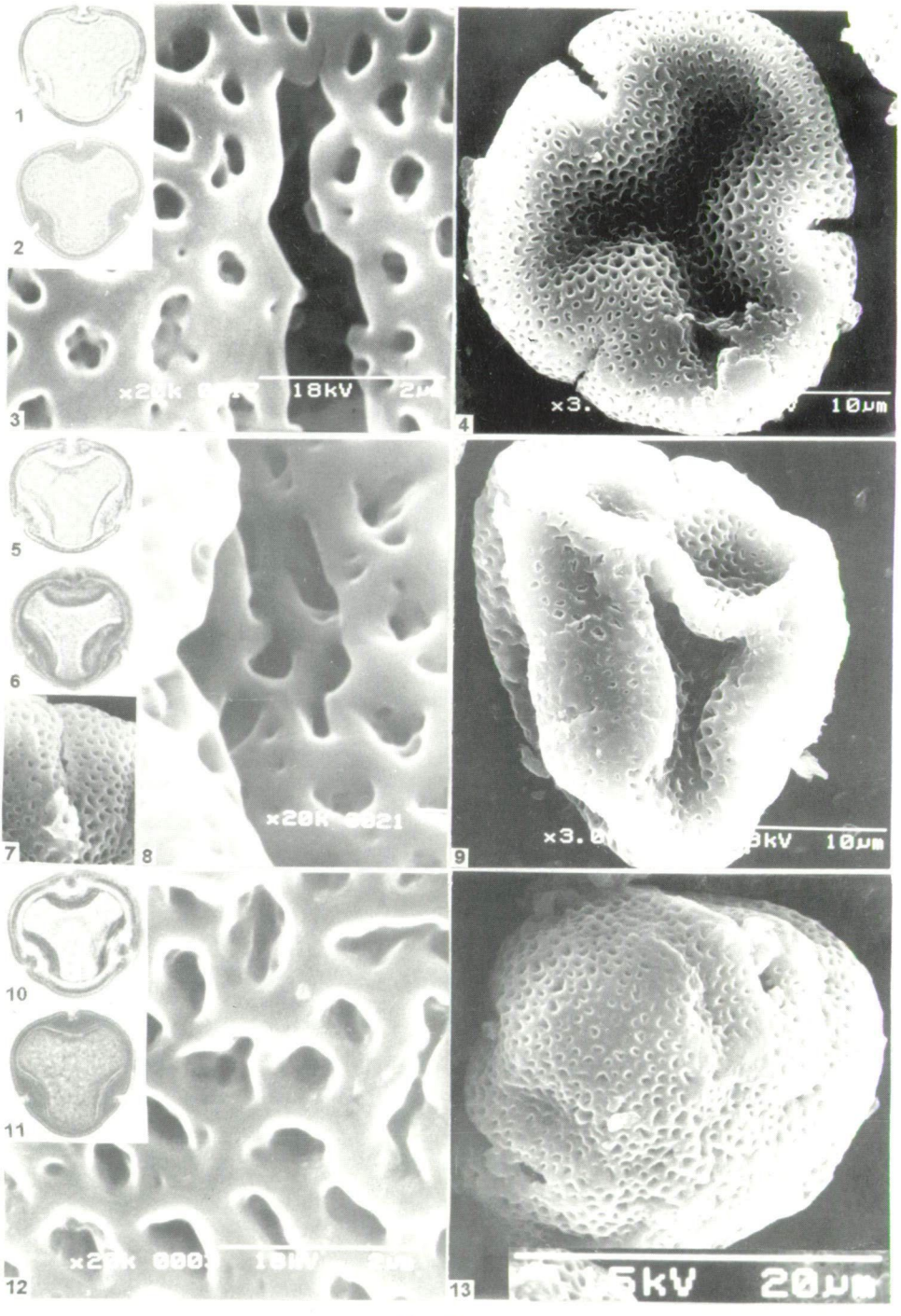


Plate 7.1.

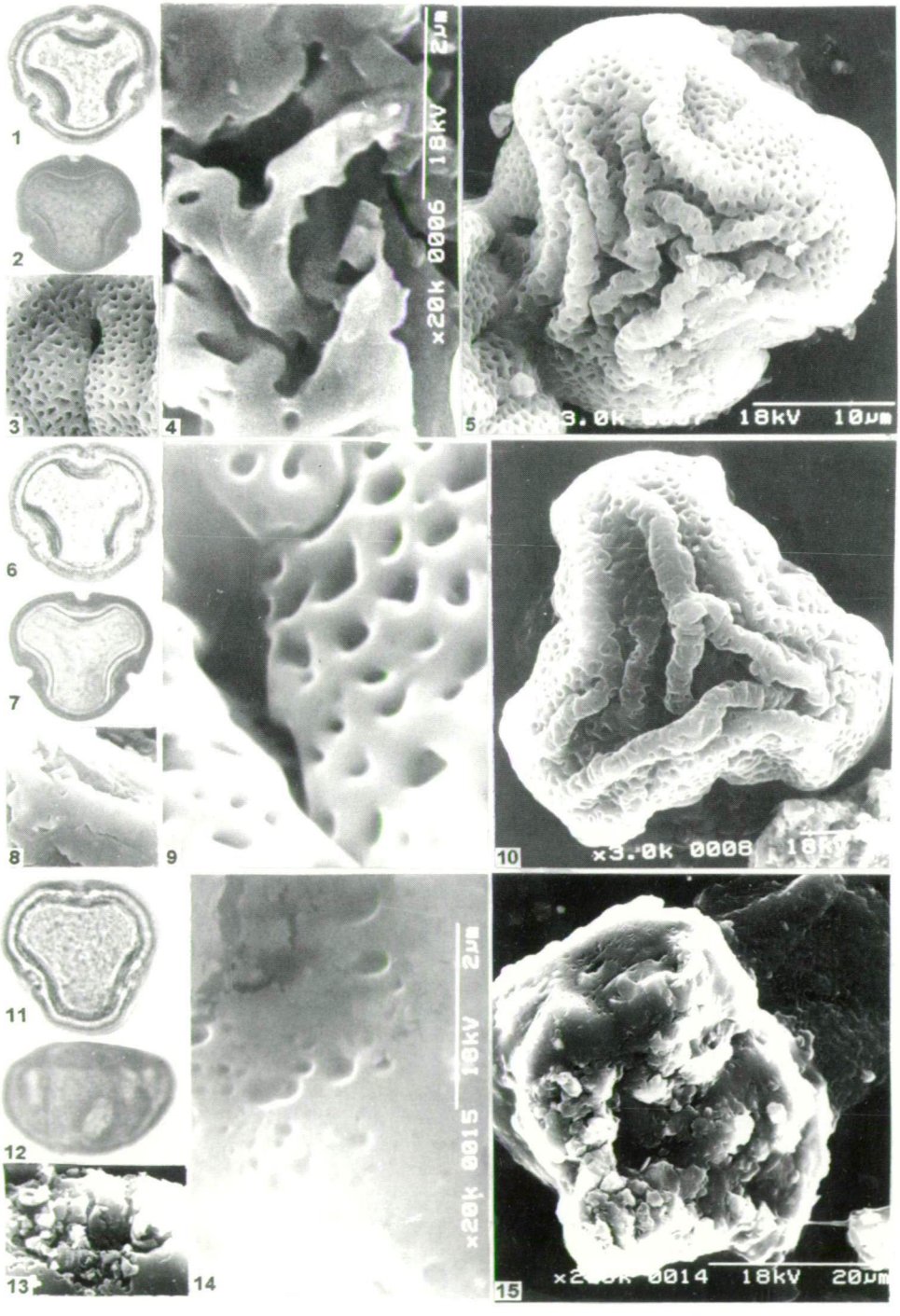

1
2
3
4
×20k 0006 18kV 2µm
5
18kV 10µm
6
7
8
9
10
×3.0k 0008
11
12
13
14
×20k 0015 18kV 2µm
15
0014 18kV 20µm

Plate 7.2.

The characteristic exoapertures (short colpi) are well shown in the non-experimental pollen grains. The tectum is not always reticulate sometimes foveolate according to the establishments of NILSSON, PRAGLOWSKI and NILSSON (1977).

Experiments T-12-43-46 resulted the characteristic plicate form which is more complicated depending on the length of time of the experiment (Plate 7.1., figs. 9,13, plate 7.2., figs. 5,10). Some alterations in the exoapertures and in the diameter of the perforations or the mesh of the reticuli are a little larger (Plate 7.1., figs. 7,8,12. plate 7.2., figs. 3,4,8,9).

The dissolution during 24 hours resulted important degradations in the basic morphology of the pollen grains. (Plate 7.2., fig. 15). The apertural area is completely altered (Plate 7.2., fig. 13), the outer layer of the ectexine are degraded. The sculpture is also different from the original one, perforation of different size were observed (Plate 7.2., fig. 14).

Discussion and Conclusions

The alterations in consequence of the 2-aminoethanol are quite different in contrast to the diethylamine. 24 hours of dissolution resulted in really important alterations based on the SEM results. In this way the molecular system of the sporopollenin is more resistant to the influence of 2-aminoethanol.

It is interesting that there are differences in the maximum value of the diameters of the unstained and stained pollen grains. We need to emphasize the very characteristic differences in samples treated for 24 hours.

The SEM method demonstrated also the extremely characteristic alterations after 24 hours of dissolution. But the plicae-like morphology appeared after 30 minutes of dissolution also.

Acknowledgements

This work was supported by Grant OTKA T 31715.

References

KEDVES, M., HORVÁTH, E., MÉSZÁROS, E., MÉSZÁROS, R., RONTÓ, G., SZLÁVIK, N., GAUDÉNYI, SZ. and KALMÁR, Á. (1998): LM investigations of partially dissolved sporomorphs II. - Plant Cell Biology and Development (Szeged) *9*, 76-87.

KEDVES, M. and KÁROSSY, Á. (1998): X-ray effect on the LM morphology of some angiosperm pollen grains II. - Plant Cell Biology and Development (Szeged) *9*, 88-92.

NILSSON, S., PRAGLOWSKI, J. and NILSSON, L. (1977): Atlas of Airborne Pollen grains and Spores in Northern Europe. - Natur och Kultur, Stockholm.

PEHLIVAN, S. (1995): Türkiye'nin alerjen polenleri atlasi. – Ünal Offset Matbaacilik Sanayi ve Ticaret Ltd. Şirketi, Ankara.

RICHARD, H., BIDAULT, M., KADMIRI, S., SIMON-RIGAUD, M.L., BOTELLA, N., CHAMBAUD, R. et ROUGEOT, J.C. (1986): Calendrier de la pluie pollinique à Besançon en 1984. - Lab. de Chron-cologie, URA n° 35 du CNRS, Faculté des Sciences, Besançon.

ROWLEY, J.R., ROWLEY, J.S. and SKVARLA, J.J. (1990): Corroded exines from Havinga's leaf mold experiment. - Palynology *14*, 53-79.

SKVARLA, J.J., ROWLEY, J.R. and CHISSOE, W.F. (1996): Corroded exines from Havinga's leaf mold experiment. SEM. - Palynology *20*, 191-207.

8. HIGH TEMPERATURE EFFECT ON RECENT POLLEN GRAINS OF TILIA CORDATA MILL. AND TILIA PLATYPHYLLOS SCOP.

M. KEDVES, A. HORVÁTH, M. MADARÁSZ, J. SASHALMI, A. SZÉCSÉNYI and D. TOMBÁCZ

Cell Biological and Evolutionary Micropaleontological Laboratory of the University of Szeged, H-6701, P.O. Box 993, Szeged, Hungary

Abstract

The LM morphological alterations were investigated as a consequence of the high temperature on 200 °C during 10 minutes, 1 hour, 5 and 10 hours. The observed alterations have not touched the basic morphological characteristic features of these pollen grains.

Key words: Palynology, recent, *Tilia*, high temperature effect, LM.

Introduction

The pollen morphology of the genus *Tilia* is interesting in evolutionary point of view. The short colpi and the peculiar endannulus are of early type, cf. ERDTMAN (1954), ERDTMAN, PRAGLOWSKI and NILSSON (1963), etc. TEM data from recent pollen grain, by CHAMBERS and GODWIN (1961). The first ultrastructure data from fossil pollen grain, (*Intratriporopollenites microreticulatus* MAI 1961), by KEDVES and PÁRDUTZ, in 1970. The reticulate surface is also one earlier sculpture type. The sporopollenin of the ectexine of *Tilia platyphyllos* SCOP. is very easily soluble in diethylamine. Morphological alterations were also observed after partial dissolution in merkaptoethanol and alcohols (KEDVES et al. 1998). These characteristic features stimulated us to continue different kinds of experiments on the pollen grains of this genus. The alteration in consequence of the high temperature as it was established in several previous papers may be important in taxonomic from an evolutionary point of view.

The aim of this paper is to establish the qualitative and the quantitative alterations of the pollen grains of two species of this genus: *T. cordata, T. platyphyllos.*

Materials and Methods

Tilia cordata MILL., collected by D. TOMBÁCZ and J. SASHALMI in Szeged (cultivated) on the 28.05.1999.
Experiment No.: T-9-41. - Fresh pollen grain (Plate 8.1., figs. 1-3)
Experiment No.: T-9-42. - Heated pollen grains, length of time 10 minutes, 200 °C (Plate 8.1., figs. 4-6)
Experiment No.: T-9-43. - Heated pollen grains, length of time 1 hour, 200 °C (Plate 8.1., figs. 7-9)
Experiment No.: T-9-44. - Heated pollen grains, length of time 5 hours, 200 °C (Plate 8.1., figs. 10-12)

Experiment No.: T-9-45. - Heated pollen grains, length of time 10 hours, 200 °C (Plate 8.1., figs. 13-15)
Tilia platyphyllos SCOP., collected by J. SASHALMI and D. TOMBÁCZ in Szeged (cultivated) on the 28.05.1999.
Experiment No.: T-9-46. - Fresh pollen grain (Plate 8.1., figs. 16-18)
Experiment No.: T-9-47. - Heated pollen grains, length of time 10 minutes, 200 °C (Plate 8.1., figs. 19-21)
Experiment No.: T-9-48. - Heated pollen grains, length of time 1 hour, 200 °C (Plate 8.1., figs. 22-24)
Experiment No.: T-9-49. - Heated pollen grains, length of time 5 hours, 200 °C (Plate 8.1., figs. 25-27)
Experiment No.: T-9-50. - Heated pollen grains, length of time 10 hours, 200 °C (Plate 8.1., figs. 28-30)
The samples were mounted in glycerine-jelly hydrated at 39.6%.

Results

Qualitative results

Tilia cordata MILL. (Plate 8.1., figs. 1-15)

The alteration of the pollen grain after 10 minutes of heating is similar to the pollen grains of *T. platyphyllos* SCOP. partially dissolved merkaptoethanol during 90, 210, 270 and 330 days, and methanol 30, 90, 150, 210, 270, 330 days, and ethanol 30, 90, 150, 210, 330 days, and n-propanol 210 days, and n-butanol 210, 270 days, and finally i-amyl alcohol 90,150, 210, 270, 330 days. After 1 hour of heating the intine and the protoplasm began dark and burned. Worth mentioning is that the granular swelled protoplasm reached the inner surface of the ectexine.

Tilia platyphyllos SCOP. (Plate 8.1., figs. 16-30)

According to the previous species, the alterations to the pollen grains are similar after 10 minutes of heating. After 1 hour of heating the intine and the protoplasm began dark and burned also. The alterations are similar or maybe identical to *T. cordata*.

Quantitative results

Experiment number	Time of heating	Size (µm, %)							Dominant size (µm)	Average (µm)
		25	27.5	30	32.5	35	37.5	40		
T-9-41	0	1	0.5	12	23	**41.5**	21	1	35	34.28
T-9-42	10 min.					24.5	**50.5**	25	37.5	37.53
T-9-43	1 hour		0.5	2.5	7	**31.5**	**41**	17.5	35; 37.5	36.58
T-9-44	5 hours				21	**34.5**	**30.5**	14	35; 37.5	35.95
T-9-45	10 hours			3.5	18	**39.5**	**34**	5	35; 37.5	35.48
T-9-46	0			5.5	27	**35**	**30.5**	2	35; 37.5	34.93
T-9-47	10 min.			1.5	3	19.5	**43.5**	**32.5**	37.5; 40	37.58
T-9-48	1 hour					20.5	**41.5**	24.5	37.5	38.27
T-9-49	5 hours				12.5	18.5	**43**	18.5	37.5	37.25
T-9-50	10 hours			1.5	16.5	**31**	**43.5**	7.5	35; 37.5	35.97

Tilia cordata MILL.

After 10 minutes of heating the size of the pollen grains increased in a remarkable manner. After 1 hour the greatest part of the pollen grains was larger than the fresh ones. This was the same after 5 and 10 hours of heating. No remarkable diminishing appeared during this kind of experiment.

Tilia platyphyllos SCOP.

The greatest diameter of the fresh pollen grains was identical to the pollen grains of the previous species after 5 hours of heating. The swelling was remarkable after 10 minutes of heating.

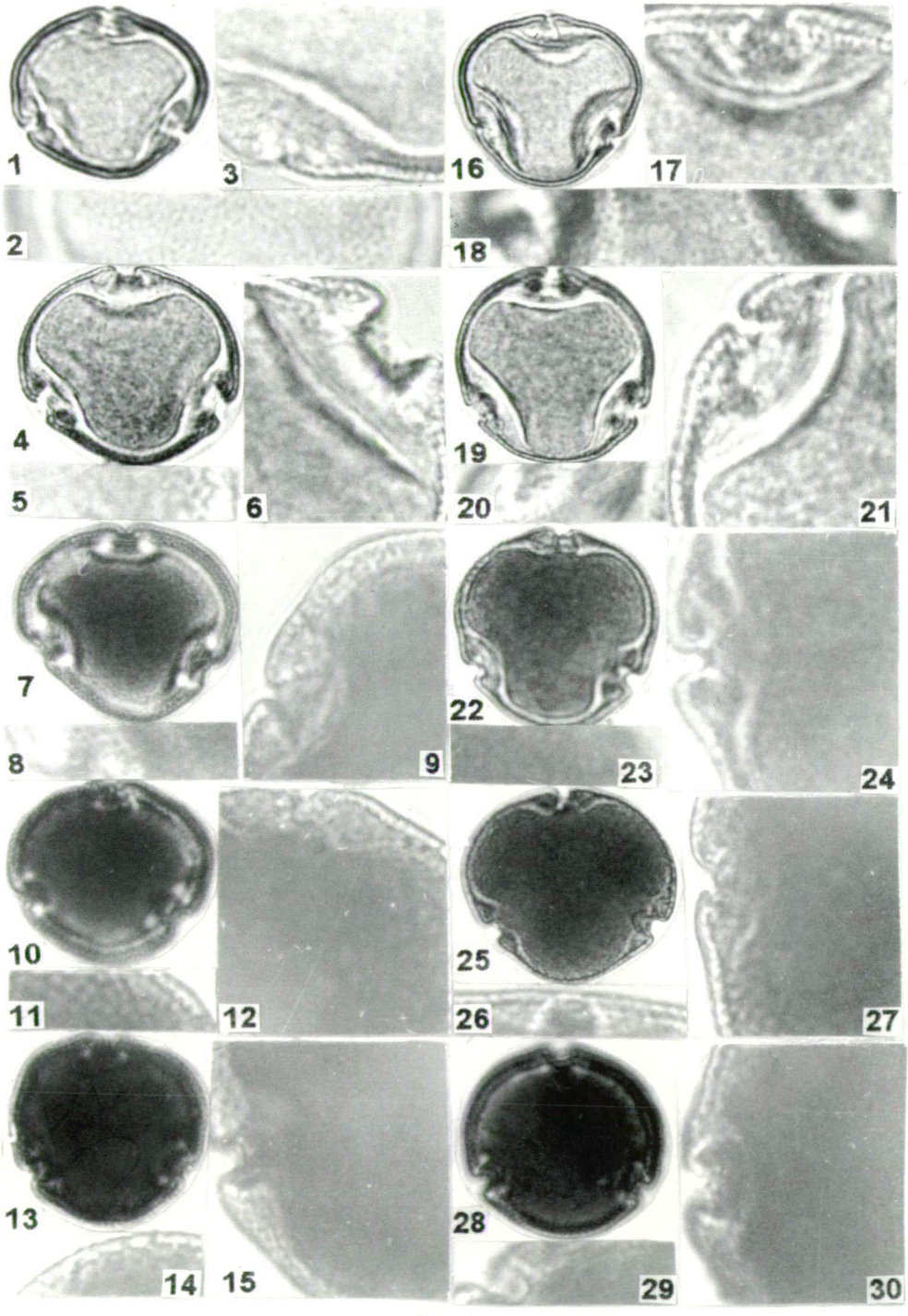

1
3
16
17
2
18
4
5
6
19
20
21
7
8
9
22
23
24
10
11
12
25
26
27
13
14
15
28
29
30

Plate 8.1.

Plate 8.1.

1-15. - *Tilia cordata* MILL., recent
1-3. - Fresh pollen grain.
4-6. - Heated pollen grain during 10 minutes.
7-9. - Heated pollen grain during 1 hour.
10-12. - Heated pollen grain during 5 hours.
13-15. - Heated pollen grain during 10 hours.
Magnification: 1, 4, 7, 10, 13 1000x, 2, 3, 5, 6, 8, 9, 11, 12, 14, 15 2500x.
16-30. - *Tilia platyphyllos* SCOP.
16-18. - Fresh pollen grain.
19-21. - Heated pollen grain during 10 minutes.
22-24. - Heated pollen grain during 1 hour.
25-27. - Heated pollen grain during 5 hours.
28-30. - Heated pollen grain during 10 hours.
Magnification: 16, 19, 22, 25, 28 1000x., 17, 18, 20, 21, 23, 24, 26, 27, 29, 30 2500x.

Discussion and Conclusions

Based on the results of the previous experiments on the pollen grains of the genus *Tilia* we can point out the following:

1. There are similarities in the secondary LM morphology after different kinds of experimental treatments: The heated pollen grains at 200 °C was similar to several partially dissolved pollen grains with alcohols.

2. The resistance to X-ray (KEDVES and KÁROSSY, 1998) irradiation is interesting in comparison to the solubility in diethylamine. The solubility in diethylamine of the wall may occur at different taxa.

3. The alteration of the diameter of the heated pollen grains during different lengths of time represent another type of alteration, which was observed in several spores and pollen grains in previous investigations of the Laboratory.

Acknowledgements

The writers are thankful to Eric CAULTON (Scottish Centre for Pollen Studies, Edinburgh, UK) for his valuable comments and for the linguistic corrections. This work was supported by Grant OTKA T 031715.

References

CHAMBERS, T. C. and GODWIN, H. (1961): The fine structure of the pollen wall of *Tilia platyphyllos*. - New Phytol. *60*, 393-399.

ERDTMAN, G. (1954): An Introduction to pollen analysis. - Almqvist and Wiksell, Stockholm.

ERDTMAN, G., PRAGLOWSKI, J. and NILSSON, S. (1963): An Introduction to a Scandinavian pollen flora. - Almqvist and Wiksell, Stockholm.

KEDVES, M., HORVÁTH, E., MÉSZÁROS, E., MÉSZÁROS, R., RONTÓ, G., SZLÁVIK, N., GAUDÉNYI, SZ. and KALMÁR, Á. (1998): LM investigations of partially dissolved sporomorphs II. - Plant Cell Biology and Development (Szeged) *9*, 76-87.

KEDVES, M. and KÁROSSY, Á. (1998): X-ray effect on the LM morphology of some angiosperm pollen grains II. - Plant Cell Biology and Development (Szeged) *9*, 88-92.

KEDVES, M. et PÁRDUTZ, Á. (1970): Études palynologiques des couches du Tertiaire inférieur de la Région Parisienne VI. Ultrastructure de quelques pollen d'Angiospermes de l'Eocène inférieur (Sparnacien). - Pollen et Spores *12*, 553-575.

MAI, D.H. (1961): Über eine fossile *Tiliaceen*-Blüte und tilioiden Pollen aus dem Deutschen Tertiär. - Geologie *10*, H *32*, 54-93.

9. LM AND TEM INVESTIGATIONS ON PARTIALLY DEGRADED POLLEN GRAINS OF ALNUS GLUTINOSA (L.) GAERTN.

M. KEDVES[1], Á. PÁRDUTZ[2], M. MADARÁSZ[1], K. PRISKIN[1], A. SZÉCSÉNYI[1], J. SASHALMI[1] and D. TOMBÁCZ[1]

1. Cell Biological and Evolutionary Micropaleontological Laboratory of the University of Szeged, H-6701, P.O. Box 993, Szeged, Hungary, 2. Institute of Biophysics, Biological Research Center of the Hungarian Academy of Sciences H-6701, P.O. Box 521, Szeged, Hungary

Abstract

This paper present the qualitative LM and TEM results of the partially degraded pollen grains of *Alnus glutinosa* (L.) GAERTN. Three series (2-aminoethanol, 2-aminoethanol + $KMnO_4$, 2-aminoethanol + merkaptoethanol) of experiments and glycerine (50%) treatment were carried out. Identities within the series of experiments were established.

Key words: Palynology, recent, *Alnus glutinosa*, experimental ultrastructure.

Introduction

Pollen grains of *Alnus glutinosa* (L.) GAERTN. are allergenic (RICHARD et al. 1986, JÁRAI-KOMLÓDI, 1991, PEHLIVAN, 1995, MOLNÁR,1999, etc.). Pollen grains of this species are included in the book of NILSSON, PRAGLOWSKI and NILSSON (1977) and LM, SEM and TEM pictures were published from the non-experimental pollen grains.

Previously different kinds of experimental studies were carried out in our Laboratory on the pollen grains of the genus *Alnus*. X-ray irradiated pollen grains of *Alnus subcordata* C. A. MEY were investigated by KEDVES and UNGVÁRI (1996). The following was established, p. 80: "The differences in the percentages of the pollen tube development of the genuses *Betula* and *Alnus* are also interesting." TEM studies of X-ray irradiated pollen grains of *Alnus glutinosa* were published by KEDVES and PÁRDUTZ (1992). Pollen grains of *Alnus glutinosa* were investigated with the LM method after partial dissolution with 7 organic solvents (i-amyl alcohol, n-butanol, n-propanol, ethanol, methanol, merkaptoethanol, diethylamine) by KEDVES, HORVÁTH, BORBOLA and TÓTH (1999). The following was concluded, p. 82: "In comparison with *Betula verrucosa* EHRH. there are minor alterations at the pollen grains of *Alnus glutinosa*." The TEM method was used for partially degraded pollen grains by different kinds of methods. The biopolymer organization was investigated by KEDVES and ROJIK (1989) on partially degraded and fragmented exines of *Alnus glutinosa*. Different kinds of organization were observed: filamentous units, basic and highly organized metastable quasi periodic biopolymer structures and helical structures also. The modified Markham rotation method was also used. KEDVES, FARKAS, MÉSZÁROS, TÓTH and VÉR (1991): "Several kinds of the modi-

fied Markham rotation method were used to verify and investigate the symmetry of the basic polygon."

This paper represent a part of our systematic studies on allergenic pollen grains with two kinds of standard methods. The qualitative LM and TEM data are presented in this paper. The aim of this paper is to present data, and comparisons with the previous results in this subject.

Materials and Methods

The investigation material was collected by M. MADARÁSZ on 18. 02. 2000 in the Botanical Garden of the University of Szeged.

The following experiments were carried out:

T-12-10: non-treated pollen grains.

T-12-11: 5 mg dry pollen grains + 1 ml 2-aminoethanol, length of time 24 h, at 30 °C.

T-12-12: 5 mg dry pollen grains + 1 ml 2-aminoethanol, length of time 48 h, at 30 °C.

T-12-13: 5 mg dry pollen grains + 1 ml 2-aminoethanol, length of time 72 h, at 30 °C.

T-12-14: 5 mg dry pollen grains + 1 ml 2-aminoethanol, length of time 24 h and 10 ml $KMnO_4$ during 24 h, at 30 °C.

T-12-15: 5 mg dry pollen grains + 1 ml 2-aminoethanol, length of time 48 h and 10 ml $KMnO_4$ during 24 h, at 30 °C.

T-12-16: 5 mg dry pollen grains + 1 ml 2-aminoethanol, length of time 72 h and 10 ml $KMnO_4$ during 24 h, at 30 °C.

T-12-17: 5 mg dry pollen grains + 1 ml 2-aminoethanol, length of time 24 h and 1 ml merkaptoethanol during 24 h, at 30 °C.

T-12-18: 5 mg dry pollen grains + 1 ml 2-aminoethanol, length of time 48 h and 1 ml merkaptoethanol during 24 h, at 30 °C.

T-12-19: 5 mg dry pollen grains + 1 ml 2-aminoethanol, length of time 72 h and 1 ml merkaptoethanol during 24 h, at 30 °C.

T-12-20: 5 mg dry pollen grains + 5 ml glycerine (50%), length of time 30 days.

LM pictures were taken from unstained and stained pollen grains mounted in glycerine-jelly hydrated and from the pollen grains after embedding in Araldite.

For TEM investigations, the pollen material was washed with distilled water, then postfixed with 1.0% OsO_4 aq. dil. and embedded in Araldite (Durcupan, Fluka). The ultrathin sections were made in the EM Laboratory of the Institute of Biophysics of the Biological Research Center of the Hungarian Academy of Sciences. The microphotographs were made on a Tesla BS-540 (resolution 6-7 Å).

Results

1. Partial degradation with 2-aminoethanol (Plate 9.1., figs. 1-22)

1.1. Experiment No.: T-12-11 (Plate 9.1., figs. 1-8)

LM results. - No taxonomically significant alterations were observed. Thinning of the ectexine and electron dense particles of the protoplasm and intine protrusions are illustrated in pictures 2-4 (Plate 9.1.). In TEM pictures (Plate 9.1., figs. 5-8), there are numerous electron dense microbodies in the protoplasm. Rarely in the intine electron dense globular units are also present (Plate 9.1., figs. 5,7). The protruding protoplasm (Plate 9.1., fig. 8) was also perceptible. Characteristic degradation of the infratectal layer and of the intine is illustrated in pictures 5-7, Plate 9.1.

1.2. Experiment No.: T-12-12 (Plate 9.1., figs. 9-16)

LM results. - Similar to the previous experiment protruding protoplasm was not observed after the treatment (Plate 9.1., figs, 9-12). TEM results (Plate 9.1., figs. 13-16), show the degradation of the infratectal layer (Plate 9.1., figs. 13-15). Rarely electron dense granules are in this layer (Plate 9.1, fig. 14). The endexine is seemingly dissolved. There are numerous electron dense microbodies in the protoplasm (Plate 9.1., figs. 13,15,16).

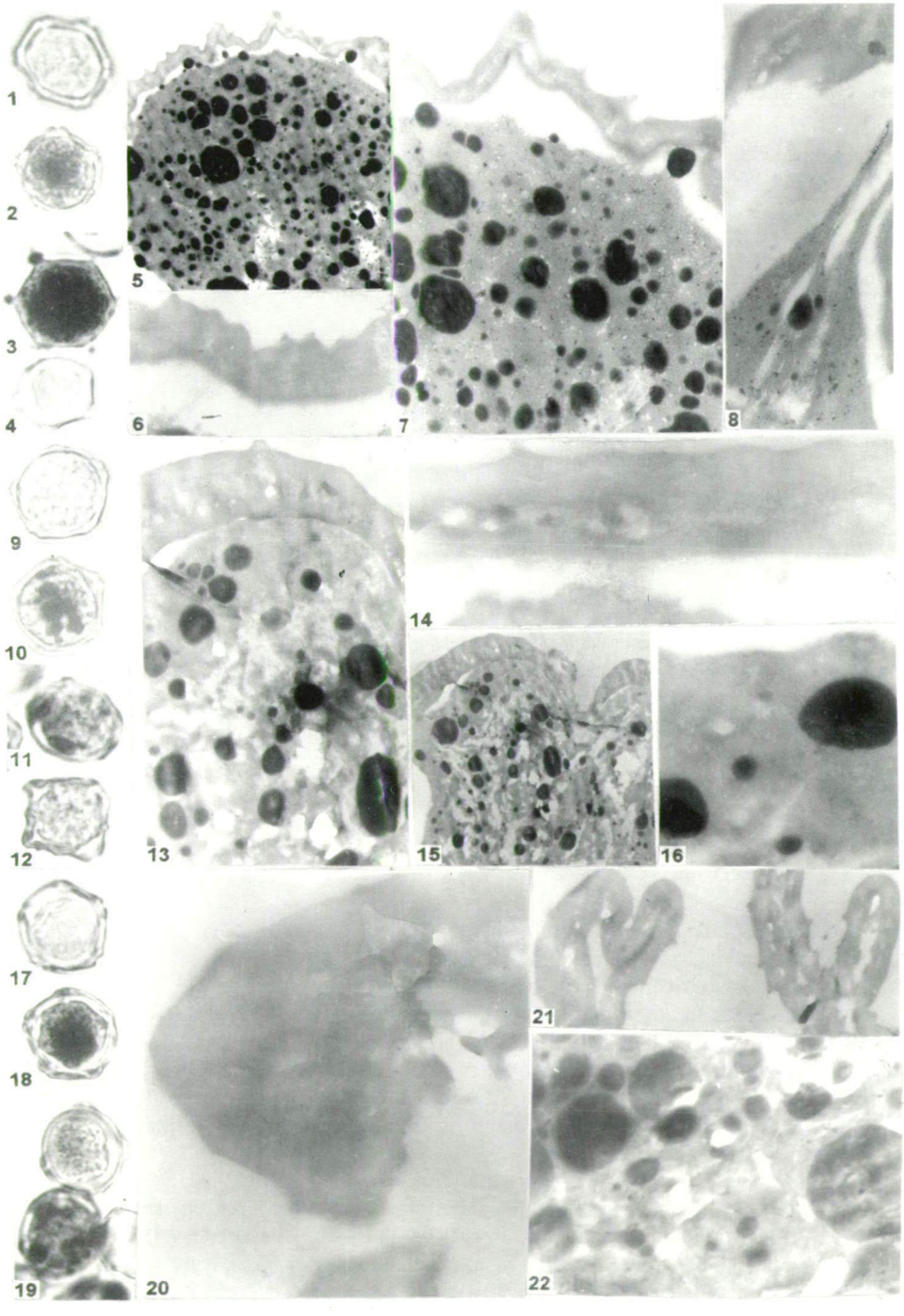


Plate 9.1.

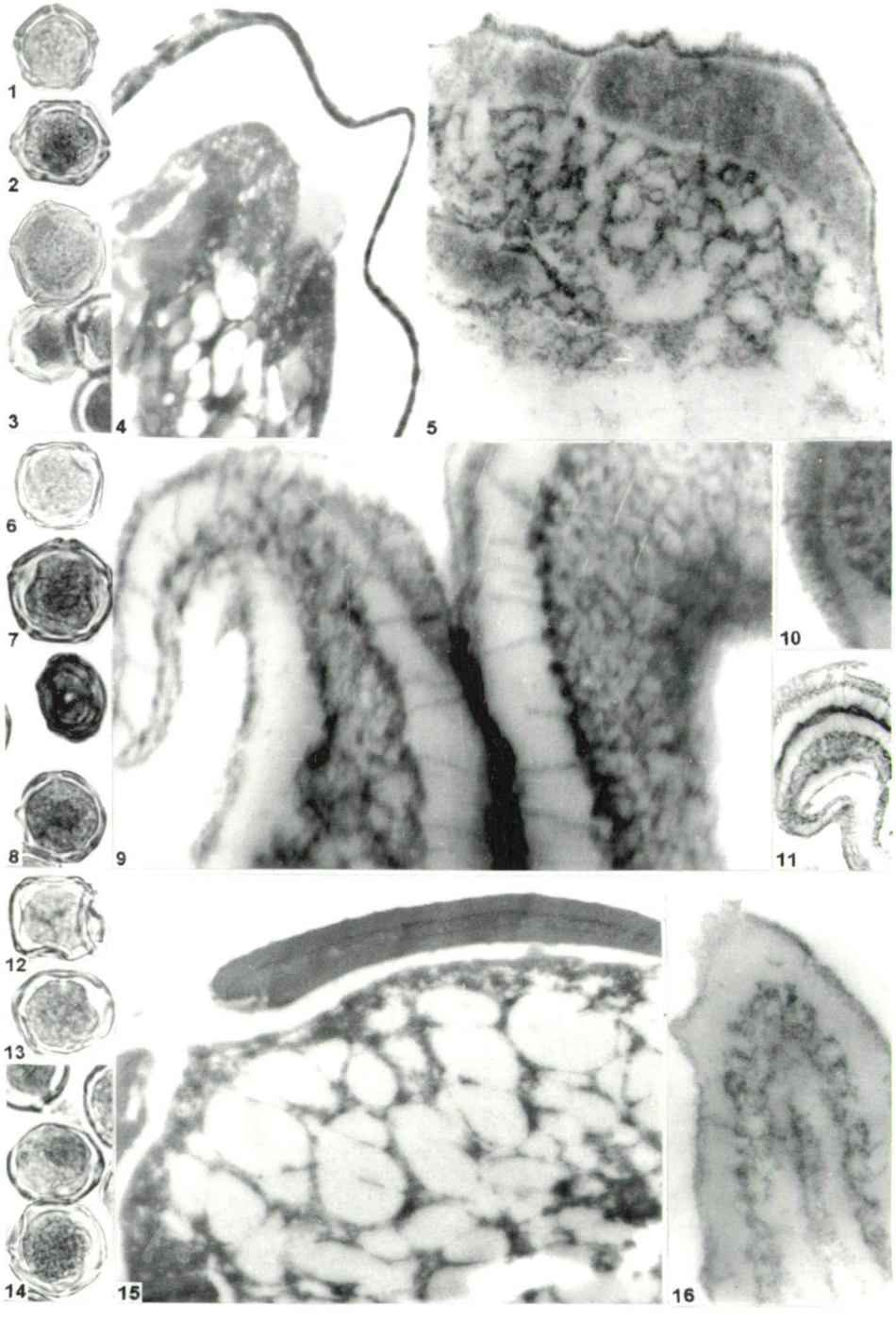


Plate 9.2.

Plate 9.1.

1-22. *Alnus glutinosa* (L.) GAERTN.
1-8. Experiment No.: T-12-11. 1-4. LM pictures, 5-8. TEM pictures, 5. Negative No: 8375, 5.000x., 6. Negative No.: 8379, 15.000x., 7. Negative No.: 8376, 15.000x., 8. Negative No.: 8378, 15.000x., 9-16. Experiment No.: T-12-12. 9-12. LM pictures, 13-16. TEM pictures, 13. Negative No.: 8310, 15.000x., 14. Negative No.: 8309, 5.000x., 15. Negative No.: 8235, 50.000x., 16. Negative No.: 8311, 50.000x., 17-22. Experiment No.: T-12-13. 17-19. LM pictures, 20-22. TEM pictures. 20. Negative No.: 8314, 50.000x., 21. Negative No.: 8213, 15.000x., 22. Negative No.: 8240, 15.000x.

Plate 9.2.

1-16. *Alnus glutinosa* (L.) GAERTN.
1-5. Experiment No.: T-12-14. 1-3. LM pictures, 4,5. TEM pictures, 4. Negative No.: 8292, 5.000x., 5. Negative No.: 8300, 50.000x., 6-11. Experiment No.: T-12-15. 6-8. LM pictures, 9-11. TEM pictures, 9. Negative No.: 8243, 75.000x., 10. Negative No.: 8244, 50.000x., 11. Negative No.: 8242, 15.000x. 12-16 Experiment No.: T-12-16. 12-14. LM pictures, 15,16. TEM pictures, 15. Negative No.: 8318, 10.000x., 16. Negative No.: 8383, 50.000x.

1.3. Experiment No.: T-12-13 (Plate 9.1., figs. 17-22)

LM results. - Identical with the previous one (Plate 9.1., figs. 17-19). The disintegration of the infratectal layer in the apertural area is characteristic (Plate 9.1., fig. 20). Morphological alterations occurred during the embedding processes, which are well shown in picture 21, Plate 9.1. The electron dense microbodies are numerous (Plate 9.1., fig. 22).

1.4. Experiment No.: T-12-14 (Plate 9.2., figs. 1-5)

LM results. - The ectexine investigated by this method seems to be not altered in a remarkable measure. There are light areas (intine) between the foot layer and the plasma membrane (Plate 9.2., figs. 1-3). TEM results. - Sometimes the outest ectexine layers are degraded. The intine, the plasma membrane and the electron dense microbodies in the protoplasm are mostly degraded (Plate 9.2., fig. 4). In the apertural area the surface of the isodiametric and anastomosing elements of the infratectal layer are degraded. Similar superficial alterations were observed on the tectum and on the foot layer. The endoaperture is also altered, remnants of the intine with lamellar ultrastructure are in the inner part of the exoaperture.

1.5. Experiment No.: T-12-15 (Plate 9.2., figs. 6-11)

LM results. - Essentially identical with the previous one (Plate 9.2., figs. 6-8). TEM results. - Alterations in the morphology of the pollen grains were also observed, which may be the consequence of the embedding processes (Plate 9.2., figs. 9,11). Characteristic degradation was observed on all surfaces of the ectexine, well shown at the channels of the tectum also.

1.6. Experiment No.: T-12-16 (Plate 9.2., figs. 12-16)

LM results. - Not so important alterations were observed (Plate 9.2., figs. 12-14), the contraction of the protoplasm is a little advanced in relation of the previous ones. TEM results. - The degradation of the protoplasm and the pollen wall is expressed (Plate 9.2., figs. 15,16). All surfaces, outer and inner of the ectexine are disintegrated these superficial parts are electron dense (Plate 9.2., fig. 16). The intine is completely disappeared. The protoplasm protrudes in the apertural area, the plasma membrane is degraded, the electron dense microbodies are completely disappeared (Plate 9.2., fig. 15).

1.7. Experiment No.: T-12-17 (Plate 9.3., 1-7)

LM results. - The protoplasm was not greatly contracted (Plate 9.3., fig. 2). TEM results. - The degradation of the ectexine is characteristic, particularly in the infratectal

layer (Plate 9.3., figs. 5-7). Electron dense particles of different size represent the infratectal layer. Relatively large electron dense globular units are in the intine. The intine is not completely disintegrated. The electron dense bodies are not degraded in the protoplasm (Plate 9.3., fig. 5).

1.8. Experiment No.: T-12-18 (Plate 9.3., figs. 8-14)

LM results. - The contraction of the protoplasm is well shown and it is heterogeneous in stain acceptance (Plate 9.3., figs. 9,11). TEM results. - Important basic morphological alterations were established in the ultrathin sections, e.g.: Plate 9.3., fig. 12. The ectexine is degraded (Plate 9.3., figs. 12,13). The intine is seemingly completely distroyed, but electron dense globular units are between the ectexine and the protoplasm. The disintegration of the organelles of the protoplasm is heterogeneous in relation to the electron dense microbodies (Plate 9.3., fig. 12). In some part of the protoplasm is filled with electron dense bodies (Plate 9.3., figs. 13,14) in other cases it is full with holes in consequence of the degradation of these particles (Plate 9.3., fig. 12).

1.9. Experiment No.: T-12-19 (Plate 9.4., figs. 15-20)

LM (Plate 9.3. figs. 15-18) and TEM (Plate 9.3., figs. 19-20) results are identical with the previous experiment.

1.10. Experiment No.: T-12-20 (Plate 9.4., figs. 1-7)

LM results. - Sometimes peculiar contraction of the protoplasm was observed (Plate 9.4., figs. 1,2), and the stain acceptance is remarkable (Plate 9.4., figs. 3,4). Dissolution of the ectexine is well illustrated in pictures 5-7, plate 9.4. The intine disappeared, the disintegration of the protoplasm is also well shown (Plate 9.4., fig. 5). There are holes, and a homogenisation of the organelles is characteristic.

Discussion and Conclusions

1. Among the LM results the following are worth of mentioning:

1.1. Protrusion of the protoplasm occurred only at the experiment T-12-11.

1.2. The stain acceptance of the protoplasm is sometimes characteristic.

1.3. Contraction of the protoplasm is important and not uniform. Peculiar contracted protoplasm was observed at the experiment No.: T-12-20 (Plate 9.4., figs. 1,2).

2. There are some identities within the experiment.

2.1. The 2-aminoethanol have not degraded the electron dense microbodies of the protoplasm.

Plate 9.3.

1-20 *Alnus glutinosa* (L.) GAERTN.
1-7. Experiment No.: T-12-17. 1-4. LM pictures, 5-7. TEM pictures, 5. Negative No.: 8267, 50.000x., 6. Negative No.: 8265, 50.000x., 7. Negative No: 8260, 5.000x., 8-14. Experiment No.: T-12-18. 8-11. LM pictures, 12-14. TEM pictures, 12. Negative No.: 8279, 5.000x, 13. Negative No.: 8280, 15.000x., 14. Negative No.: 8274, 5.000x. 15-20. Experiment No.: T-12-19. 15-18. LM pictures, 19,20. TEM pictures, 19. Negative No.: 8282, 15.000x., 20. Negative No.: 8282, 25.000x.

Plate 9.4.

1-7. *Alnus glutinosa* (L.) GAERTN.
Experiment No.: T-12-20. 1-4. LM pictures, 5-7. TEM pictures 5. Negative No.: 8324, 10.000x, 6. Negative No.: 8322, 25.000x, Negative No.: 8286, 50.000x.

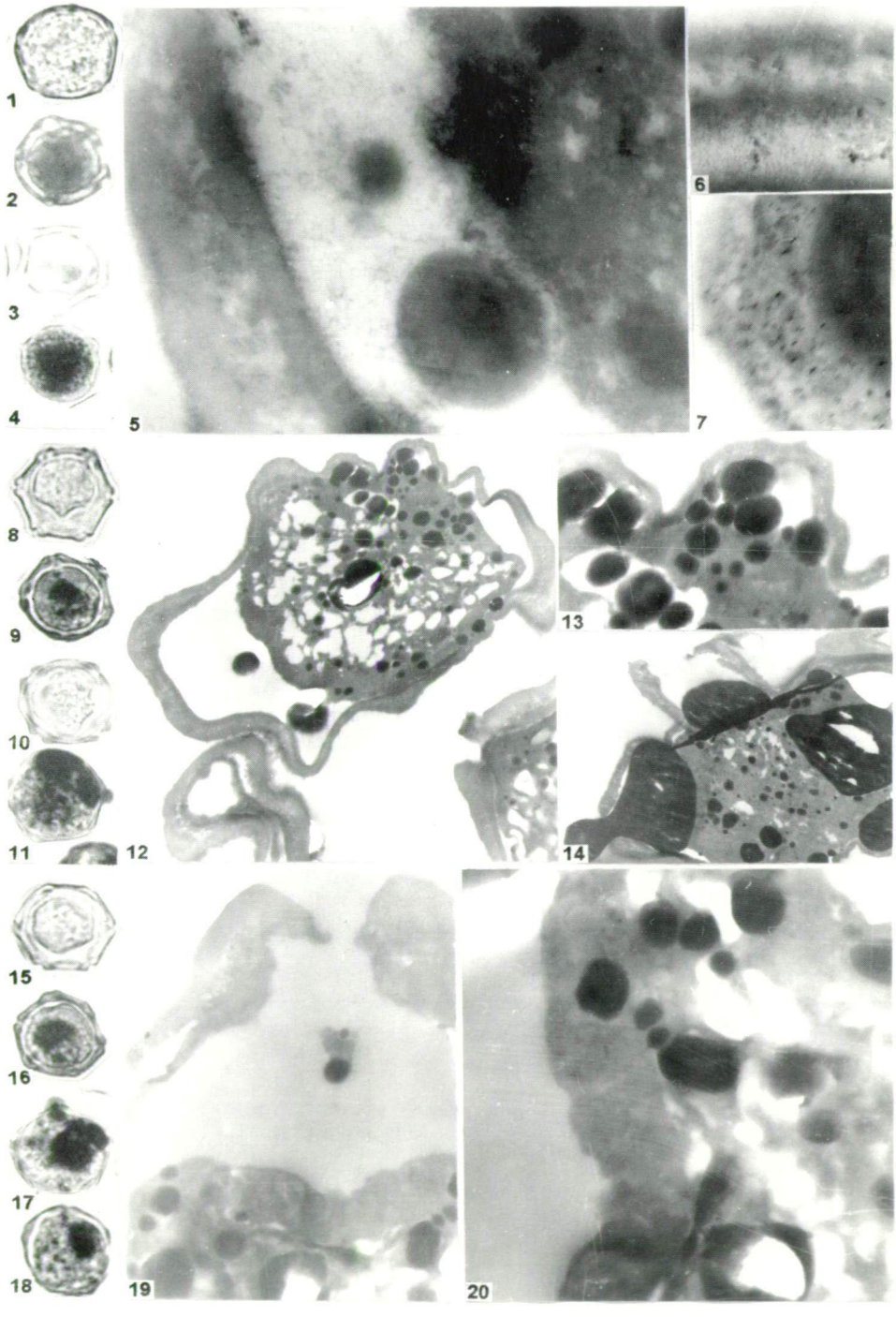


Plate 9.3.

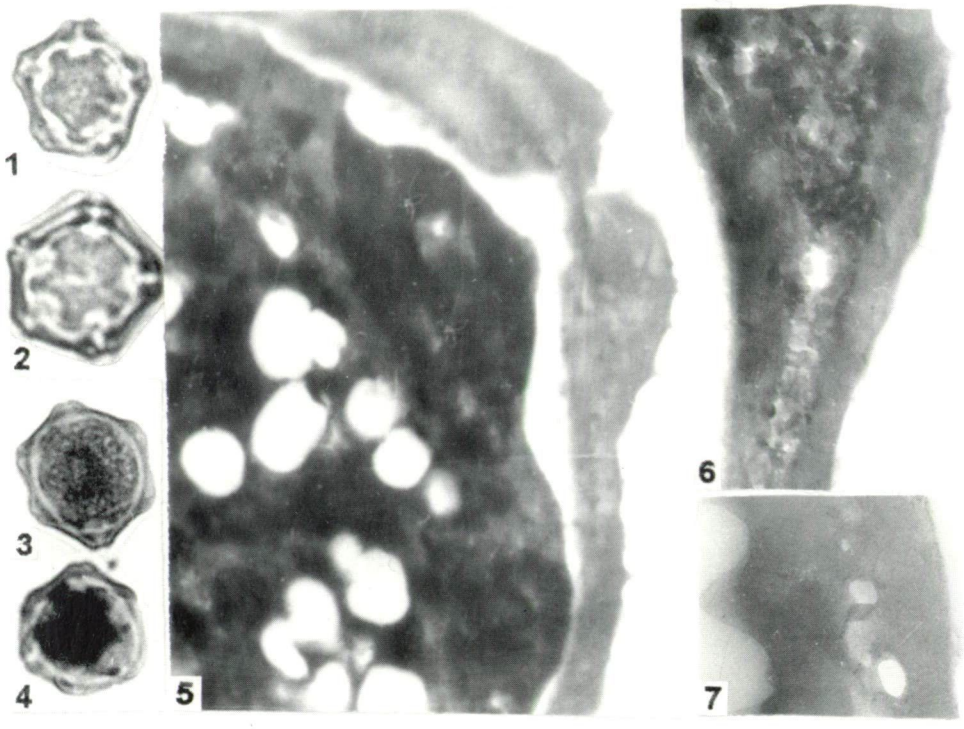


Plate 9.4.

2.2. The $KMnO_4$ after 2-aminoethanol degraded the particles of the protoplasm. The biopolymer system of the ectexine was discovered by these experiments.

2.3. Particular deformations were also observed which are the consequence of the embedding processes, because such deformations were not observed in the LM pictures.

2.4. Concerning the experiments which were combined with merkaptoethanol the electron dense globular units in the intine can be emphasized. These resistant units are in all probability of pollenkitt origin. Similar small electron dense granules were published by NILSSON, PRAGLOWSKI and NILSSON (1977), from non-experimental pollen grains of *Alnus glutinosa* in the onci.

2.5. In contrast to the results on the partially dissolved pollen grains of *Platanus hybrida* protoplasm organelles were not discovered by the partial dissolution with 50% glycerine.

Acknowledgements

This work was supported by Grant OTKA T 031715.

References

JÁRAI-KOMLÓDI, M. (1991): First results of a study on airborne sporomorphs in Budapest, Hungary - Grana *30*, 464-466.

KEDVES, M., FARKAS, E., MÉSZÁROS, K., TÓTH, A. and VÉR, A. (1991): Investigations on the basic biopolymer structure of the ectexine of *Alnus glutinosa* (L.) GAERTN. - Plant Cell Biology and Development (Szeged) *2*, 49-58.

KEDVES, M., HORVÁTH E., BORBOLA, A. and TÓTH, A. (1999): LM investigations of partially dissolved sporomorphs III. - Plant Cell Biology and Development (Szeged) *10*, 75-82.

KEDVES, M. and PÁRDUTZ, Á. (1992): X-ray effect to the exine ultrastructure of *Alnus glutinosa* (L.) GAERTN. - Taiwania *37*, 123-133.

KEDVES, M. and ROJIK, I. (1989): Investigations of the biopolymer organization of partially degraded exines with the fragmentation method. - Acta Biol. Szeged. *25*, 71-80.

KEDVES, M. and UNGVÁRI, E. (1996): X-ray effect to the LM morphology of some gymnosperm and angiosperm pollen grains. - Plant Cell Biology and Development (Szeged) *7*, 75-81.

MOLNÁR, T. (1999): A levegőben található pollenek morfológiai vizsgálata és dinamikája. - Doktori (PhD) Értekezés, DATE. MGT Kar, Növénytani és Növényélettani Tanszék.

NILSSON, S., PRAGLOWSKI, J. and NILSSON, L. (1977): Atlas of Airborne Pollen Grains and Spores in Northern Europe. - Natur och Kultur, Stockholm.

PEHLIVAN, S. (1995): Türkiye'nin alerjen polenleri atlasi. - Ünal Offset, Matbaacilik Sanayi ve Ticaret Ltd. Şirketi, Ankara.

RICHARD, H., BIDAULT, M., KADMIRI, S., SIMON-RIGAUD, M.L., BOTELLA, N., CHAMBAUD, R. et Rougeot, J.C. (1986): Calendrier de la pluie pollinique à Besançon en 1984. - Publ. Lab. de Chrono-Ecol., URA n° *35*, du CNRS, 1-32.

10. EXPERIMENTAL STUDIES ON THE POLLEN GRAINS OF ELAEAGNUS ANGUSTIFOLIA L.

M. KEDVES and M. MADARÁSZ

Cell Biological and Evolutionary Micropaleontological Laboratory of the University of Szeged, H-6701, P.O. Box 993, Szeged, Hungary

Abstract

LM morphological alterations were investigated by the high temperature effect on 200 °C, during 10 minutes, 1 hour, 5 hours, 10 hours, and after partial dissolution with 2-aminoethanol during different length of time. The qualitative and the quantitative variations of the maximum size of the pollen grains were investigated and evaluated.

Key words: Palynology, recent, *Elaeagnus angustifolia*, LM, high tempertaure effect.

Introduction

The LM morphology of the pollen grains of *Elaeagnus angustifolia* is of an early type within the *angiosperms*. Short colpi represent the exoaperture, and triangular amb in polar view. Previously non-acetolyzed and acetolyzed pollen grains were investigated with the LM, TEM and SEM methods isolated from buds and open flowers (KEDVES and PÁRDUTZ, 1982). It was established, that the acetolysis considerably changed the size of the pollen grains. Based on the TEM results it was pointed out, that pollen grains of *Elaeagnus angustifolia* may be regarded the morphological analogies of *Complexiopollis* KRUTZSCH 1959 emend. TSCHUDY 1973, without supposing direct botanical relationship between the two. Later it was established that the pollen grains of this species are resistant against X-ray irradiation (KEDVES and KÁROSSY, 1998). Surprising results were published by KEDVES and Erika HORVÁTH (2000) namely, the sporopollenin of the ectexine is less resistant as it is easily dissolved or degraded with organic solvents.

The aim of this contribution is to investigate the alterations of the LM morphology during the high tempertaure effect and the partial dissolution in 2-aminoethanol, including the quantitative characteristic features.

Materials and Methods

1. The pollen material was collected on the 10th April 1999.

Experiment No.: T9-P-19. - 20 stamen + 2 ml 2-aminoethanol, temperature 30 °C, length of time: 5 minutes.

Experiment No.: T9-P-20. - 20 stamen + 2 ml 2-aminoethanol, temperature 30 °C, length of time: 10 minutes.

Experiment No.: T9-P-21. - 20 stamen + 2 ml 2-aminoethanol, temperature 30 °C, length of time: 15 minutes.

Experiment No.: T9-P-22. - 20 stamen + 2 ml 2-aminoethanol, temperature 30 °C, length of time: 20 minutes.

Experiment No.: T9-P-23. - 20 stamen + 2 ml 2-aminoethanol, temperature 30 °C, length of time: 25 minutes.

Experiment No.: T9-P-24. - 20 stamen + 2 ml 2-aminoethanol, temperature 30 °C, length of time: 30 minutes.

Experiment No.: T9-P-25. - 20 stamen + 2 ml 2-aminoethanol, temperature 30 °C, length of time: 35 minutes.

Experiment No.: T9-P-26. - 20 stamen + 2 ml 2-aminoethanol, temperature 30 °C, length of time: 40 minutes.

Experiment No.: T9-P-27. - 20 stamen + 2 ml 2-aminoethanol, temperature 30 °C, length of time: 45 minutes.

Experiment No.: T9-P-28. - 20 stamen + 2 ml 2-aminoethanol, temperature 30 °C, length of time: 50 minutes.

Experiment No.: T9-P-29. - 20 stamen + 2 ml 2-aminoethanol, temperature 30 °C, length of time: 55 minutes.

Experiment No.: T9-P-30. - 20 stamen + 2 ml 2-aminoethanol, temperature 30 °C, length of time: 60 minutes.

2. The investigation material was collected on the 26th April 1999. Fresh and heated pollen grains on 200 °C during 10 minutes, 1hour, 5, 10 hours were investigated. Experiments numbers: T9-P-10, T9-P-11, T9-P-12, T9-P-13 and T9-P-14.

Results

Quantitative data of the partially dissolved pollen grains with 2-aminoethanol

Experiment number	Time of dissolution	Size (µm %)									Dominant size (µm)	Average (µm)
		32.5	35	37.5	40	42.5	45	47.5	50	52.5		
T9-P-19	5 min.	0.5	0.5	25	**35**	24	11.5	3.5			40	40.75
T9-P-20	10 min.				10	**41.5**	**37**	10.5	1		42.5; 45	43.78
T9-P-21	15 min.			2.5	10	**37**	**37**	12	1.5		42.5; 45	43.75
T9-P-22	20 min.				10	**43**	**42**	5			42.5; 45	43.55
T9-P-23	25 min.			2	10	**35.5**	**37**	14	1.5		42.5; 45	43.88
T9-P-24	30 min.			1	23.5	**44.5**	27	4			42.5	42.75
T9-P-25	35 min.				6	29.5	**45.5**	17.5	1.5		45	44.48
T9-P-26	40 min.		0.5	21	**33**	**34.5**	10	1			40; 42.5	40.90
T9-P-27	45 min.				0.5	19.5	**46**	29.5	4.5		45	45.45
T9-P-28	50 min.				5.5	**47.5**	39.5	7	0.5		42.5	43.75
T9-P-29	55 min.				0.5	11.5	**39**	**39**	9	1	45	46.20
T9-P-30	60 min.				9.5	**37**	**37.5**	15	1		42.5	44.03

Quantitative data of the heated pollen grains.

Experiment number	Time of heating	Size (µm, %)										Dominant size (µm)	Average (µm)
		30	32.5	35	37.5	40	42.5	45	47.5	50	52.5		
T9-P-10	0	1	4	31	**47.5**	16	0.5					37.5	36.8
T9-P-11	10 min.					3.5	8	29	**38**	20	1.5	47.5	46.7
T9-P-12	1 hour					2.5	13	**32.5**	**32**	17.5	2.5	45; 47.5	46.4
T9-P-13	5 hours				0.5	2	21	**42**	27	7	0.5	45	45.4
T9-P-14	10 hours					2	18	**42**	29.5	8	0.5	45	45.63

Qualitative alterations of the investigated pollen grains

There are minuscul alterations in consequence of the experiment. That the high temperature effect (Plate 10.1., figs. 4-15) was of no taxonomic significance, was surprising. The protruding character of the apertural area of the fresh pollen grains (Plate 10.1., figs. 1-3) disappeared. Alterations in the convexity of the sides of the pollen grains were not observed.

Discussion and Conclusions

1. The relative stability of the taxonomic important morphological characteristic features of these pollen grains is interesting.

2.1. The diameter of the pollen grains increased after short heating, which is more or less a general phenomenon.

2.2. The diminishing started after 1hour of heating, which is nearly constant at 45 µm. The average measure is 36.88 µm of the fresh pollen grains and of the heated pollen grains is the following were: 46.7 µm (10m), 46.4 µm (1h), 45.4 µm (5h), 45.63 µm (10h). In this way this characteristic feature is independent of the length of time of the heating. But the alterations of the per cents of the pollen grains of 42.5 µm indicate a significant trend: 0.5% (non heated), 8.0% (10m), 13.0% (1h), 21.0% (5h), 18.0% (10h).

3. The diameter of the partially dissolved pollen grains increased in general but the trend is irregular.

As final conclusion we can emphasize that the observed alterations are unusual in comparison with our several previous results of the heated or partially dissolved pollen grains.

Acknowledgements

The writers are greatly indebted to Mr. Eric CAULTON (Scottish Centre for Pollen Studies, Edinburgh, UK) for his comments and linguistic corrections of the text. This work was supported by the Grant OTKA T 031715.

Plate 10.1.

Elaeagnus angustifolia L. recent.
1-3. - Fresh pollen grains.
4-6. - Heated pollen grains during 10 minutes.
7-9. - Heated pollen grains during 1 hour.
10-12. - Heated pollen grains during 5 hours.
13-15. - Heated pollen grains during 10 hours.
Magnification: 1, 4, 7, 10, 13 1000x; 2, 3, 5, 6, 8, 9, 11, 12, 14, 15 2500x.

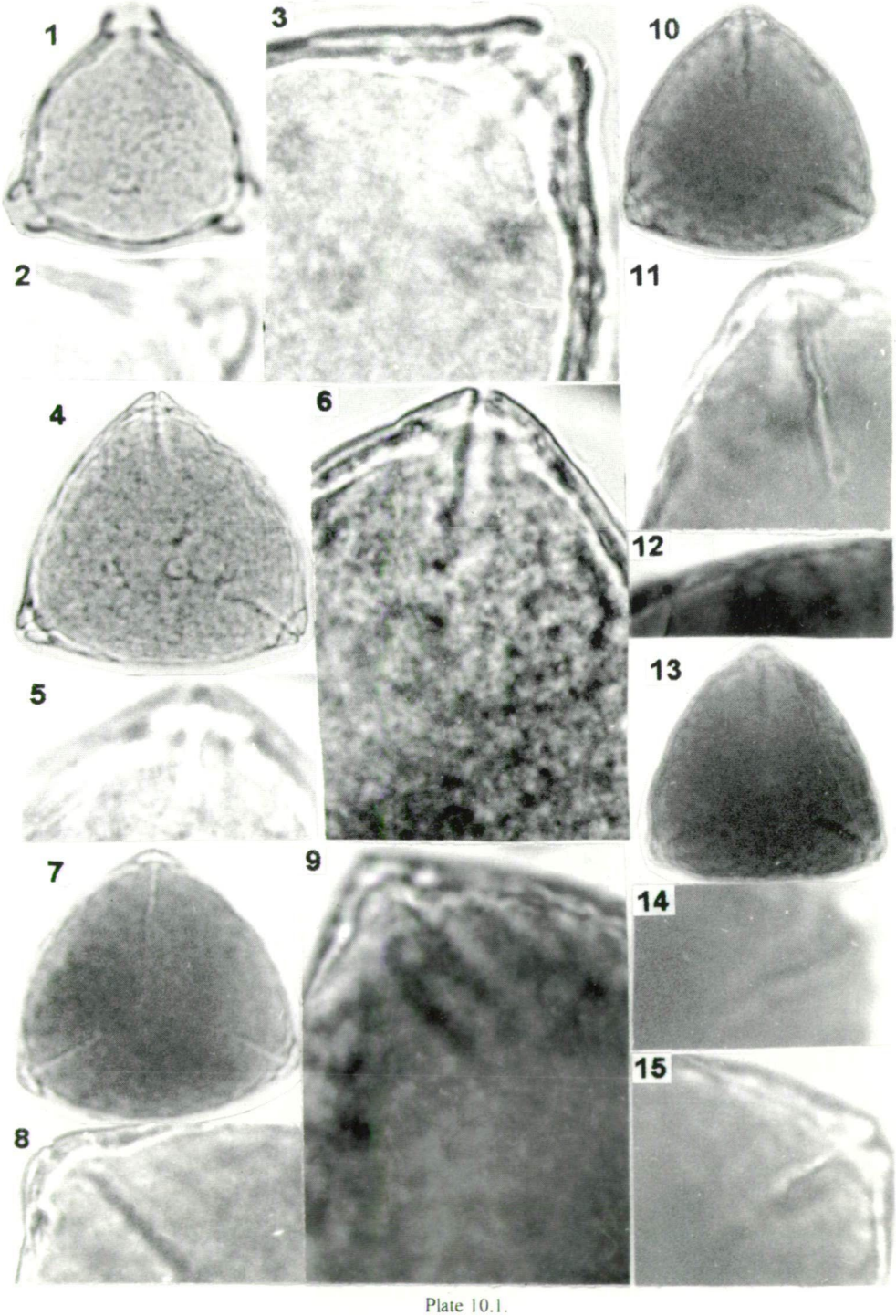


Plate 10.1.

References

KEDVES, M. and HORVÁTH, Erika (2000): LM and TEM investigations of partially dissolved and degraded pollen grains of *Elaeagnus angustifolia* L. - Plant Cell Biology and Development (Szeged) *11*, 150-154.

KEDVES, M. and KÁROSSY, Á. (1998): X-ray effect on the LM morphology of some *angiosperm* pollen grains II. - Plant Cell Biology and Development (Szeged) *9*, 88-92.

KEDVES, M. and PÁRDUTZ, Á. (1982): Complex studies on the pollen grains of *Elaeagnus angustifolia* L. - Acta Biol. Szeged. *28*, 75-83.

KRUTZSCH, W. (1959): Einige neue Formgattungen und -Arten von Sporen und Pollen aus der mitteleuropäischen Oberkreide und dem Tertiär. - Palaentographica *B, 105*, 125-157.

TSCHUDY, R.H. (1973): *Complexiopollis* pollen lineage in Mississippi embayment rocks. - Contributions to Paleontology Geol. Surv. Prof. Paper *743*-C, C1-C15.

11. SYMMETRY OPERATIONS ON THE QUASI-CRYSTALLOID BIOPOLYMER SYSTEM OF THE SPOROPOLLENIN OF PHOENIX SYLVESTRIS LINN. FROM INDIA

M. KEDVES[1], A. HORVÁTH[1], S.K.M. TRIPATHI[2] and MADHAV KUMAR[2]

1. Cell Biological and Evolutionary Micropaleontological Laboratory of the University of Szeged, H-6701, P.O. Box 993, Szeged, Hungary, 2. Birbal Sahni Institute of Palaeobotany, 53 University Road, Lucknow, India

Abstract

Partially degraded pollen of *Phoenix sylvestris* LINN. were investigated and exine was studied with the help of transmission electron microscopy. More or less radially oriented and comparatively large regular pentagon biopolymer units were observed on the tectal surface. This biopolymer unit was examined by using the rotation method. In the peripherial region of the pentagonal biopolymer unit peculiar Penrose units were also noticed.

Key words: Palynology, biopolymer symmetry, sporopollenin, *Phoenix sylvestris*.

Introduction

During our joint research programme on the extant palm pollen from India experiments were conducted to partially degraded the exine of *Phoenix sylvestris*. Transmission electron microscopic observations on exine were published (KEDVES et al., 2000). During these studies a regular pentagonal unit was observed (KEDVES et al., l.c., fig. 1, Plate 7.4.) and was chosen for the symmetry operation studies. The aim of the present communication is to document the biopolymer symmetry in the exine of *Phoenix sylvestris* using rotation methods. This method was previously used to study the biopolymer symmetry in the walls of *Botryococcus braunii* KÜTZING isolated from Hungarian Upper Tertiary oil shales (KEDVES et al., 1995). The rotation method has, for the first times, been used to observe the biopolymer symmetry in recent palm pollen. These studies will be very useful in comparing the results from *Botryococcus* colonies and those the *Phoenix sylvestris*.

Materials and Methods

The biopolymer unit which is the object of our present investigation (Plate 7.4., fig. 1, KEDVES et al., 2000) was obtained after a partial degradation of exine with 2-aminoethanol for 72 hours (experiment No.: 1/7-1316). The globular units of the observed regular pentagon are numbered and were studied for the symmetry operations in the same sequence. Two kinds of primary rotations (fivefold and tenfold) were carried out. The extreme secondary points ten and four were studied for two kinds of secondary rotations. Observations of the primary and secondary rotations are illustrated in Plates 11.1.-11.4. The secondary radial rotation

(R, cf. KEDVES, TÓTH and VÉR, 1993, 1995) was made for the points of symmetry of the tenfold rotation, the parallel (X, cf. KEDVES, 1989) for the points of symmetry of the fivefold rotation.

Results

Fivefold primary rotation
C.P.5.A.5.5. (Plate 11.1.)

This rotation reinforced the regular pentagon. Around the pentagon ten points of symmetry appeared in two further pentagons. The first is composed by light units, this was followed by positive (dark) but not so characteristic ten points of symmetry. In this case we numbered these points of symmetry as 1/1 - 1/10. These points of symmetry form the boundary of the outer rotation area. At the peripheral region of the picture four points of symmetry appeared, which may be a part of another pentagon formed of the several points of symmetry, but in this case provisional designation has been used (2/1 - 2/4).

The above mentioned positive secondary points of symmetry were used for secondary rotations. The parallel axis method was used, so the axes of the secondary rotations are parallel to the primary PA axis.

Secondary fivefold rotations
C.S.X.$_{+1/1}$.5.5. (Plate 11.1.)

Two characteristic positive regular pentagons appeared. The position of the points of symmetry alternate. This is surrounded by a light star-like area, which is a characteristic rotation area. Around this area there are further points of symmetry both positive and negative.

C.S.X.$_{+1/2}$.5.5. (Plate 11.1.)

A characteristic dark pentagon appeared, which was surrounded by a light star-like area. At each side of light star-like area two dark points of symmetry were observed. Outside of these areas several further positive and negative points of symmetry appeared.

C.S.X.$_{+1/3}$.5.5. (Plate 11.1.)

Peculiar secondary picture appeared. A dark star is surrounded by a light area. At the sides of this light area there are dark points of symmetry forming a regular pentagon. In pentagonal arrangement five peculiar light fields of symmetry appeared. These fields are composed by a light central point further connected to three of the four smaller light points of symmetry. Similar but dark fields are in radial position to these light fields, forming a more or less regular large secondary rotation area.

C.S.X.$_{+1/4}$.5.5. (Plate 11.1.)

A more or less circular central dark field appeared after this rotation, which is surrounded by a very characteristic light star-like area. At the sides of this light star, characteristic dark points of symmetry are noticed. This regular area is surrounded by light and dark points of symmetry. These points are irregularly arranged, which may be due to the position of the original biopolymer unit.

C.S.X.$_{+1/5}$.5.5. (Plate 11.1.)

A central light small pentagon appeared, which is further surrounded by five similar small light pentagons. Five dark points of symmetry around these light areas are present. These dark points of symmetry are a little elongated, but arranged in a regular pentagon. Several further more or less elongated light and dark points of symmetry surround this pentagon.

C.S.X.$_{+1/6}$.5.5. (Plate 11.1.)

Elongated or twin points of symmetry characterize this secondary rotation. Further, the outermost large pentagon composed of five globular dark units is clearly seen. Surrounding this a large rotation area is observed, but the whole area is not covered in the picture.

C.S.X.$_{+1/7}$.5.5. (Plate 11.1.)

A very characteristic large light rotation area characterize this rotation. The central small light star-like pentagon is surrounded by five wedge-like dark units of symmetry. Similar types of points follow this pentagon, but the units of the edges are more globular. More or less globular or radially ellipsoidal points of symmetry form another pentagon, which is "embedded" in the light rotation area. This light rotation area is delineated but dark elongated or fusioned points of symmetry are also seen.

C.S.X.$_{+1/8}$.5.5. (Plate 11.1.)

An unusual light rotation area appeared around the central rotation point. This light area of a pentagonal symmetry is surrounded by ten dark more or less characteristic points of symmetry. Five dark points of symmetry form a large outer pentagon. These dark units are surrounded by light irregular fields.

C.S.X.$_{+1/9}$.5.5. (Plate 11.1.)

A dark regular pentagon field appeared after this rotation. At the edges of this pentagon more or less dark globular points of symmetry are present. Further five, not so characteristic irregular "points" of symmetry appeared. This rotation area is bordered by a light rotation area.

C.S.X.$_{+1/10}$.5.5. (Plate 11.1.)

A dark central pentagon is surrounded by five light irregular points of symmetry. This is followed by five characteristic dark points of symmetry which are connected with further smaller dark globular or irregular units of the regular pentagon field. A large regular outermost rotation area with five dark points of symmetry close to this large biopolymer unit is noticed.

C.S.X.$_{+2/1}$.5.5. (Plate 11.1., plate 11.2., fig. 1)

Several dark and light points of symmetry appeared after this secondary rotation. These are bordered with a large pentagon composed of twenty dark points of symmetry. The light globular units surrounding the central units are not so characteristic informing the real pentagonal structure. Around this area at the sides there are five pentagonal units, but the outermost two points of symmetry are very characteristic. But one of the basic units is a little clear than others. This is because of the arrangement of the biopolymer system. The three others represent a component of the pentagonal area. In the peripherial region one can presume the pentagonal structures.

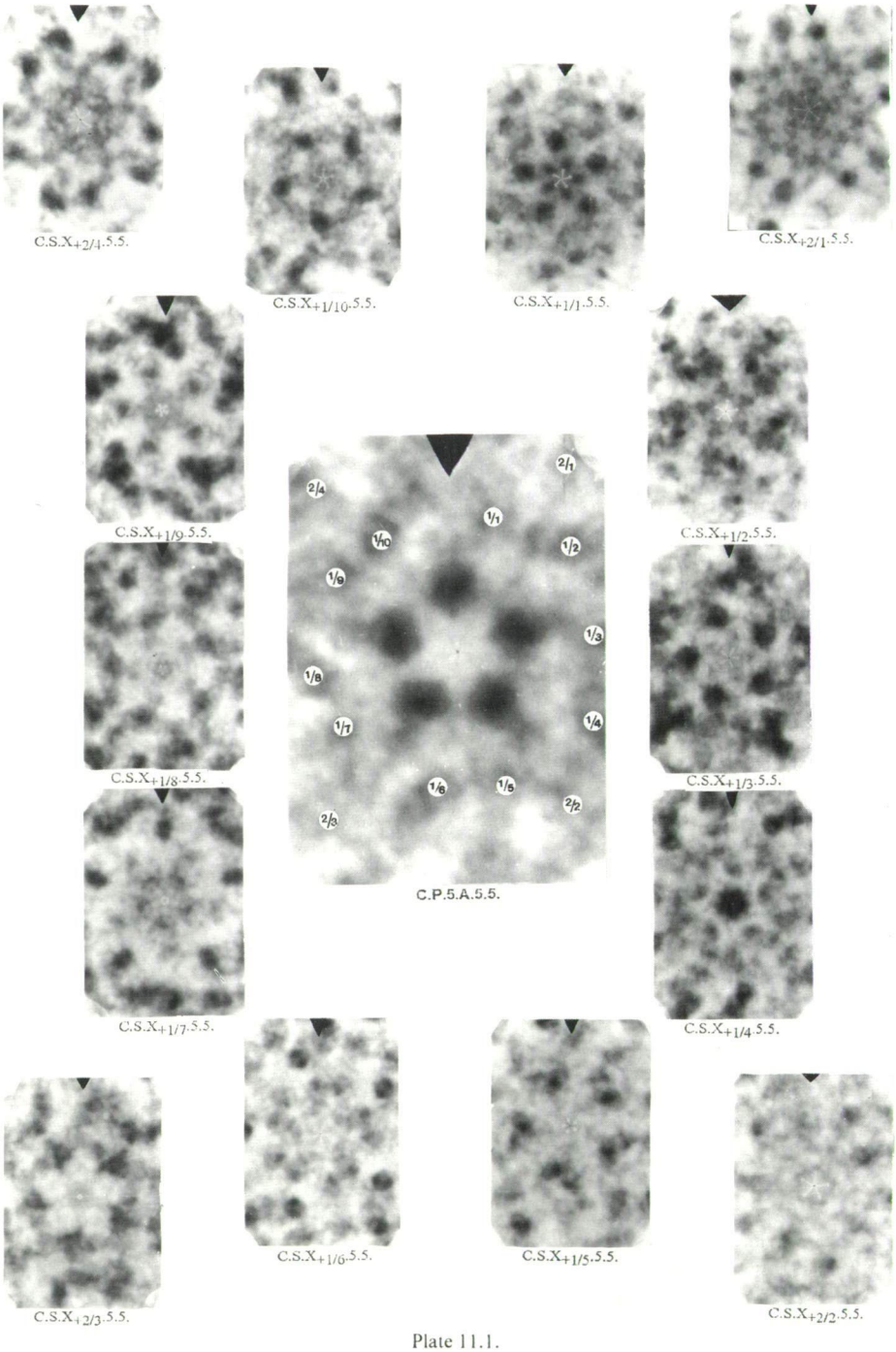


Plate 11.1.

Fivefold primary rotation picture (1,000.000x) and secondary rotation pictures (500.000x).

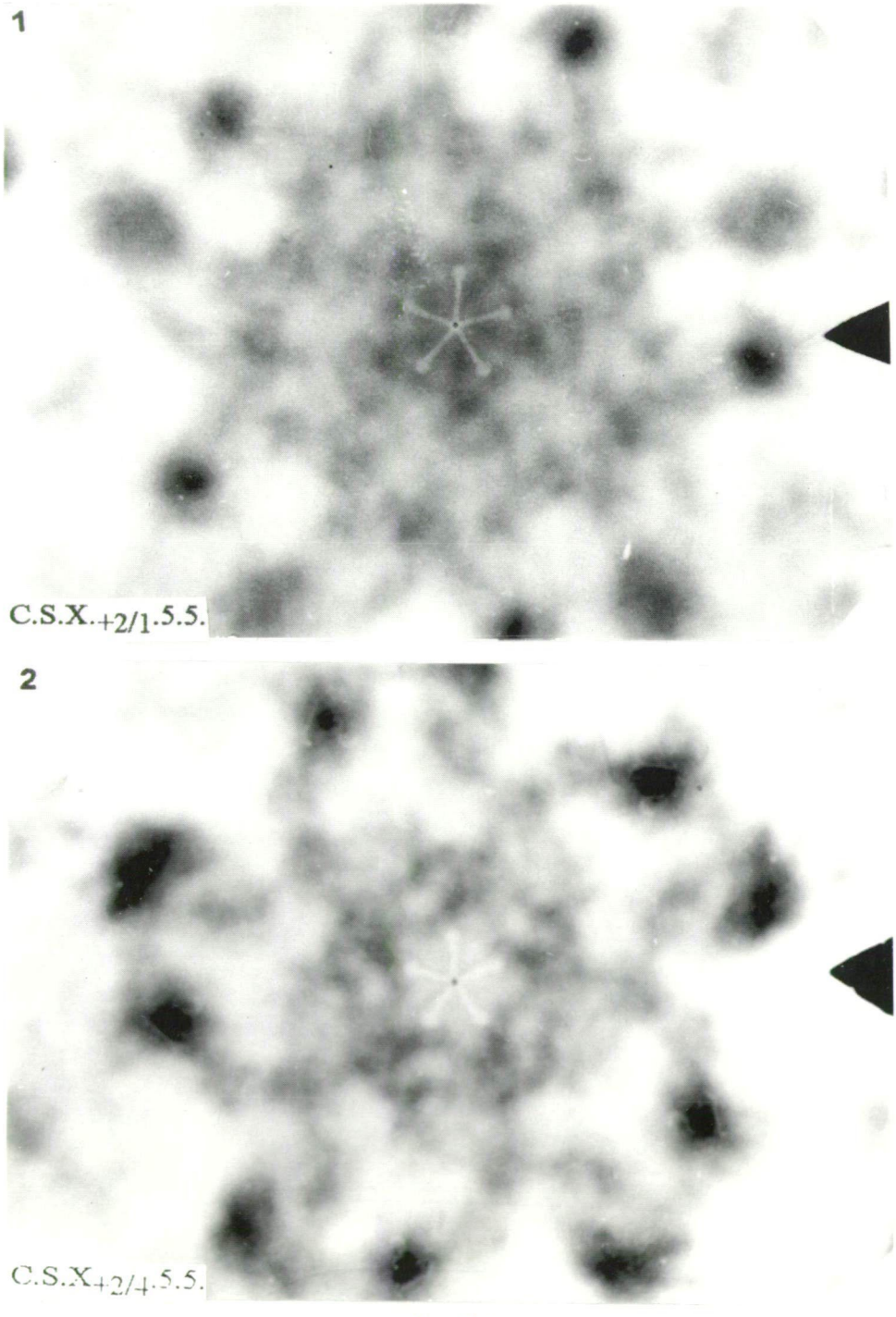


Plate 11.2.

1,2. Secondary rotation pictures (2.000.000x).

C.S.X.$_{+2/2}$.5.5. (Plate 11.1.)

A light star-like inner area appeared after this rotation. This is surrounded by a dark one, which is composed of anastomosing globular units, five at the apices and other five at the sides. This is followed by a light and dark zone surrounded by network zone. Beneath this zone pentagons similar to the basic biopolymer unit are also observed. In the outermost rotation zone there are large dark globular biopolymer units.

C.S.X.$_{+2/3}$.5.5. (Plate 11.1.)

Five small dark points of symmetry appeared after this rotation, which are enclosed with a light zone. At the edges of the peculiar central pentagon large dark points of symmetry are noticed. There are further dark units of irregular form after this dark zone. This is surrounded by five light elongated irregular elements which border the outermost rotation area.

C.S.X.$_{+2/4}$.5.5. (Plate 11.1., plate 11.2., fig. 2)

As a result of this rotation an interesting Penrose unit is noticed. Probably this is the first rotation picture which represents the quasi-crystalloid structure in space. In the centre there is pentagon dodecahedron unit, which is further surrounded by five pentagonal structures.

Tenfold primary rotations

C.P.5.A.5.10. (Plate 11.3.)

Around this rotation centre a light, more or less circular zone appeared. This is followed by a dark zone composed of ten anastomosing points of symmetry. Further ten light and ten dark points of symmetry are observed. Around this dark zone at the edges of this rotation picture there are four more or less characteristic dark points of symmetry. The points of symmetry are numbered as 5/1-5/4.

Secondary radial rotations

C.S.5.$R_{3+1/1-10}$.5.5. (Plate 11.3.)

Dark elongated areas arranged in a whorl fashion appeared in the centre after the rotation. Within this dark whorl area there are five light points of symmetry, which are made up of two or three units. This dark area is surrounded with a light zone. More or less radially oriented points of symmetry are around this star-shaped field. These 10 points form a pentagonal structure.

C.S.5.$R_{3+2/1-10}$.5.5. (Plate 11.3.)

Five curved dark elongated elements of symmetry appeared, which are embedded in a light pentagonal rotation area. Around this area there are ten dark points of symmetry which may be in the outermost rotation area. Different kinds of irregular elements are also seen around this area.

C.S.5.$R_{3+3/1-10}$.5.5. (Plate 11.3.)

Five dark points of symmetry appeared after this rotation. These points of symmetry are surrounded with a small light zone. This zone is connected with ramifying light zones. These light zones surround five dark more or less spike forming dark zones.

These dark zones are composed by about six globular units of symmetry an outermost similar zone may also be presumed.

C.S.5.$R_{3+4/1-10}$.5.5. (Plate 11.3.)

A central pentagonal dark zone appeared, which is composed of anastomosing globular units. The number of these globular elements is about ten. A relatively large circular light zone around this pentagon is present. This zone is probably composed of anastomosing globular light elements. There are five radially oriented light ramifying processes in this zone. This zone is encircled by a dark zone followed by another light zone.

C.S.5.$R_{3+5/1-10}$.5.5. (Plate 11.3.)

Dark, five radially oriented points of symmetry appeared after this rotation. Concave triangular light zones surrounding the dark elements form a more or less pentagonal rotation area. Around this area there are several light rotational elements of irregular shapes are seen.

C.S.5.$R_{3+6/1-10}$.5.5. (Plate 11.3.)

A light star-shaped zone appeared after this rotation. The sides of this light area are surrounded with five elongated dark rotation elements forming a pentagon which is surrounded with a relatively large light area. There are ten globular light points of symmetry connected to this area. In the outer region of the network light elements surround this large light pentagonal rotation area.

C.S.5.$R_{3+7/1-10}$.5.5. (Plate 11.3.)

A small dark star-shaped area surrounded by a light zone represents the inner rotation area. Ten very characteristic dark globular points of symmetry follow the light pentagon. Five light, more or less irregular elements of symmetry follow the inner dark pentagon.

C.S.5.$R_{3+8/1-10}$.5.5. (Plate 11.3.)

A small dark pentagon appeared after this rotation. This is surrounded by a light zone. Five dark points of symmetry are the direction of the edges of the pentagon. The light zone is connected to five outer large points of symmetry. Between the large light points there are ten dark points of symmetry which sometimes anastomose. Outside the peripheral rotation area there are further light and dark points of symmetry which sometimes anastomose.

C.S.5.$R_{3+9/1-10}$.5.5. (Plate 11.3.)

A small light pentagon area appeared after this rotation. This is surrounded by five dark points of symmetry. This is surrounded by a relatively large light area. From the edges of this pentagon light more or less irregular rotation fields are in radial direction. Outside of this rotation area there are five light originally pentagons, with a dark point of symmetry in the centrum.

C.S.5.$R_{3+10/1-10}$.5.5. (Plate 11.3.)

Five irregular radially oriented light fields surrounded by five characteristic dark points of symmetry appeared after this rotation. Around this dark pentagonal zone at the sides there are further dark points of symmetry.

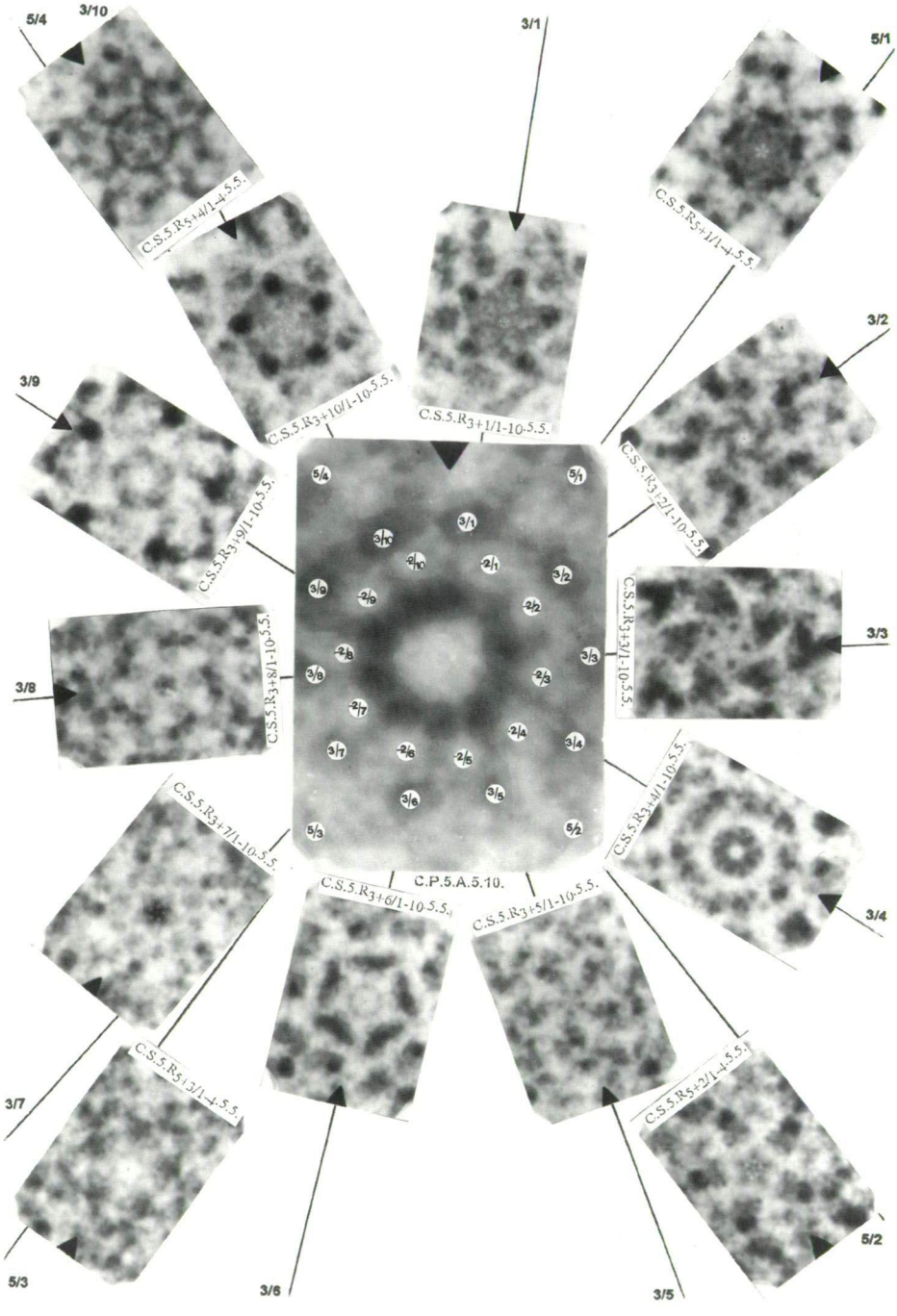
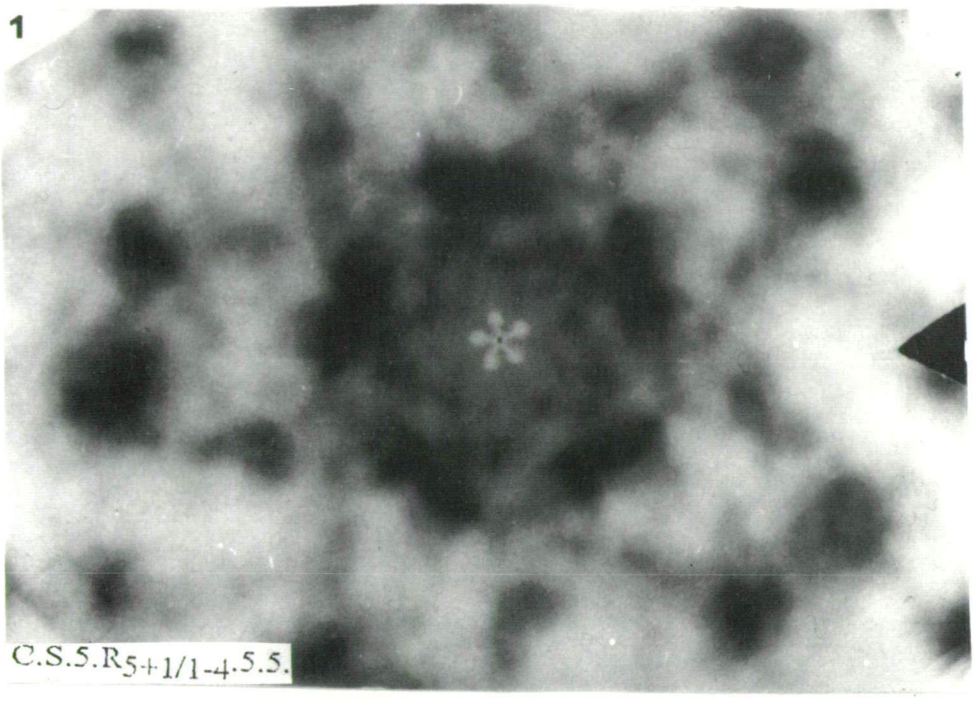


Plate 11.3.

Tenfold primary rotation picture (1,000.000x) and secodary radial rotation pictures (500.000x).



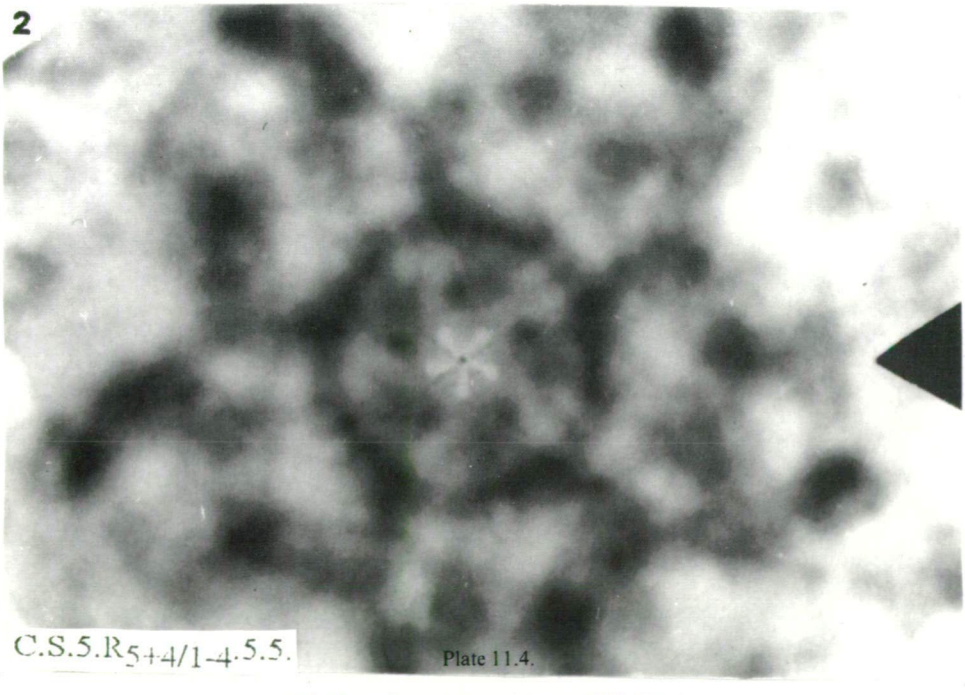


Plate 11.4.

1,2. Secondary rotation pictures (2,000.000x).

C.S.5.$R_{5+1/1-4}$.5.5. (Plate 11.3., plate 11.4., fig. 1)

Around the center two pentagons composed of dark points of symmetry are seen. These central units are connected to five other pentagons which are connected by apices to the central unit. This rotation resulted into very interesting Penrose biopolymer structure.

C.S.5.$R_{5+2/1-4}$.5.5. (Plate 11.3.)

In the rotation centre a dark pentagon appeared which is surrounded by a light zone. The light zone is connected to further light units, which may be pentagons in another space configuration.

C.S.5.$R_{5+3/1-4}$.5.5. (Plate 11.3.)

An interesting rotation area appeared after this rotation. In the centre there is a light star-shaped field, its edges shows further five points of symmetry. Radially around the inner rotation area there are five characteristic dark points of symmetry. Five irregular light rotation elements follow this and further five more or less globular points of symmetry close to this rotation area are present. This characteristic pentagonal area is surrounded with further rotation elements, which may compose the outer rotation zone.

C.S.5.$R_{5+4/1-4}$.5.5. (Plate 11.3., plate 11.4., fig. 2)

This rotation also resulted into a very interesting Penrose unit of the quasi-crystalloid biopolymer skeleton. The central unit is surrounded with five seemingly characteristic pentagon dodecahedrane unit. These results have been reported for the first time in these kind of researches.

Discussion and Conclusions

1. The points of symmetry of the five- and tenfold primary rotations are not so characteristic.

2. The pictures of the two kinds of the secondary rotations illustrate the peculiar secondary points of symmetry or different kinds of elements having resembling trends in organization patterns. More or less similar kinds of disposition of the points of symmetry are noticed.

3.1. A central pentagon dodecahedron unit is seen surrounded by five pentagon dodecahedron biopolymer system (Plate 11.2., fig. 2, plate 11.4., fig. 2).

3.2. The secondary pentagon dodecahedron units are connected at one of the sides of the central pentagon dodecahedron.

3.3. The resulting two dimensional pictures have proved very useful in establishing the molecular arrangement of the quasi periodic biopolymer network in the three dimension.

3.4. Irregularly arranged biopolymer units were observed in pollen wall of *Phoenix sylvestris*. The rotation pictures also show its irregular arrangement.

3.5. The allergenic *Ambrosia (Asteraceae)* pollen grains also exhibit irregular arrangement of biopolymer units (KEDVES et al., 1999). Some palm pollen grains are also allergenic e.g.: *Livistona*, CHEN and HUANG, (1980), *Phoenix canariensis* CHABAUD, LA-SERNA RAMOS et al., (1989), *Astrocaryum mexicanum* LIEBM. ex MART., *Chamaedorea ernesti-angusti* H. WENDL. in OTTO et DIETR., *Chamaedorea tepejilote* LIEBM. ex MART., *Geonoma oxycarpa* MART., *Reinhardtia gracilis* (H. WENDL.) DRUDE ex

DAMER var. *gracilior* (BURRET) H. MOORE, SOCORRO LOZANO-GARCIA and MARTINEZ HERNÁNDEZ (1990), *Areca catechu, Phoenix hanceana*, HUANG, (1998). From India: Bombay, *Cocos nucifera, Borassus flabellifer*, PRASAD and TRIPATHI (1986); following AGASHE and MANJUNATH (1991), p. 13: "New types of allergens which are not tested for allergies in Bangalore like *Mimosa, Dodonaea, Phoenix, Casuarina* and *Cocos* were recorded in significant numbers." The allergenic character of these pollen may thus be linked with the biopolymer organization in pollen walls and may be one of the factors for causing allergy. The future studies will throw more light on this aspect.

Acknowledgements

S.K.M. TRIPATHI and MADHAV KUMAR are grateful to Prof. A.K. SINHA, Director Birbal Sahni Institute of Palaeobotany, Lucknow for granting permission to carry out this collaborative work. This work was supported by Grant OTKA T 031715.

References

AGASHE, S.N. and MANJUNATH, K. (1991): Pollen calendar of Jnanabharathi Campus, Bangalore University, Bangalore: A suburban locality near Bangalore. - 6th National Conf. on Aerobiology, Abstracts, 12,13.

CHEN, S.-H. and HUANG, T.-c. (1980): Aeropalynological Study of Taipei Basin, Taiwan. - Grana *19*, 147-155.

HUANG, T.-c. (1998): Airborne Pollen Grains and Spores in Taiwan. - Taipei, Taiwan R.O.C.

KEDVES, M. (1989): Méthode d'étude des biopolymères de la paroi pollinique à structure quasi-cristalloïde. A method of investigation of the quasi-crystalloid structure of the pollen wall biopolymers. - Revue de Micropaléontologie *32*, 226-234.

KEDVES, M., BORBOLA, A., TRIPATHI, S.K.M. and MADHAV KUMAR (2000): Transmission electron microscopic studies on partially degraded pollen grains of *Phoenix sylvestris* LINN. - Plant Cell Biology and Development (Szeged) *12*, 93-103.

KEDVES, M., PÁRDUTZ, Á., MADARÁSZ, M. et HORVÁTH, A. (1999): Microscopie électronique à transmission de l'exine partiellement dégradée de grains de pollen *d'Ambrosia artemisiifolia.* - XVIème Symposium de l'A.P.L.F., Liège, Résumés, 70.

KEDVES, M., TÓTH, A. and VÉR, A. (1993): Radial fivefold rotation: A new method in the study of the biopolymer organization of the sporoderm. - XV. Int. Bot. Congr., Yokohama, Abstracts, 28.

KEDVES, M., TÓTH, A. and VÉR, A. (1995): Radial fivefold rotation: A new method in the study of the biopolymer organization of the sporoderm. - Plant Cell Biology and Development (Szeged) *6*, 44-59.

LA-SERNA RAMOS, I., MENDEZ PEREZ, B., DOMINGUEZ SANTANA, M.D. and ACEBES GINOVES, J.R. (1989): Contribución al atlas aeropalinológico de la Comarca de Santa Cruz-La Laguna (Tenerife: Islas Canarias) - IV. - Bol. Soc. Brot. Ser. 2, *62*, 155-182.

PRASAD, R.K. and TRIPATHI, D.M. (1986): Dominant aero-allergens in Bombay. - 3rd Internat. Conf. on Aerobiology, Abstracts, 74.

SOCORRO LOZANO-GARCIA, M. del and MARTINEZ HERNÁNDEZ, E. (1990): Palinologia de la estacion de biologia tropical Los Tuxtlas Parte I Especies Arbóreas. – Publicaciones especiales del Instituto de Biologia *3*, 1-61.

12. MICROSCOPIE ÉLECTRONIQUE À TRANSMISSION DE L'EXINE PARTIELLEMENT DÉGRADÉES DE GRAINS DE POLLEN DE QUELQUES CYCADALES

M. KEDVES[1], Á. PÁRDUTZ[2], ZS. TERBE[1] et E. HORVÁTH[1]

1. Laboratoire de Biologie cellulaire et de Micropaléontologie évolutive de l'Université de Szeged, H-6701, B.P. 993, 2. Laboratoire de Microscopie électronique de l'Institut biophysique du Centre biologique de l'Académie des Sciences de Szeged, H-6701, B.P. 521, Szeged, Hongrie

Sommaire

Dans cet article nous présentons les résultats suivants obtenus par la microscopie électronique: 1. Ultrastructure des grains de pollen de *Cycas circinalis* dissous partiellement pendant 30 jours à 30 °C par huit solvents organiques: diethylamine, mercaptoethanol, méthanol, éthanol, propanol, alcool butylique, i-alcool amylique et glycérine. 2. La dégradation partielle de l'exine avec 2-aminoéthanol et de potassium permanganate a été effectuée en six variantes aux grains de pollen de *Ceratozamia mexicana* et *Encephalartos ferox*. Trois degrés ont été établis dans la dégradation de l'exine. La dégradation moyenne a révélé le système de biopolymère de la sporopollenine de l'exine. 3. Pour étudier la symétrie de biopolymères la dégradation partielle par acide acétique anhydrique, 2-aminoéthanol, et potassium permanganate ont donné les meilleurs résultats. Nous présentons les résultats des rotations d'un pentagone régulier négatif du tectum de *l'Encephalartos ferox.*

Mots clés: Palynologie, *Cycadales*, actuel, dégradation partielle, MET.

Introduction

Les grains de pollen des *Cycadales* ont une importance primordiale dans l'évolution des grains de pollen des *angiospermes* en Hémisphère du Nord à l'intérieur de la province des *Normapolles*. Étant donné que la morphologie à la microscopie photonique est ressemblante aux certains grains de pollen des *palmiers,* la méthode de la microscopie électronique à transmission a été utilisée pour les espèces actuelles et les fossiles. Pour l'ultrastructure de grains de pollen actuels citons les travaux suivants: AFZELIUS (1956), UENO (1960), PETTITT (1966), GULLVÅG (1966), ERDTMAN et DUNBAR (1969), SKVARLA et ROWLEY (1970), AUDRAN (1970, 1974, 1978a,b, 1979a,b, 1980, 1981), AUDRAN et MASURE (1976, 1977, 1978), ZAVADA (1983), XI YI-ZHEN et WANG FU-HSIUNG (1989), XI YI-ZHEN (1990), KEDVES (1994). La structure de biopolymère de l'intine a été étudiée par KEDVES (1991), des grains de pollen de *l'Encephalartos ferox.* En ce qui concerne les formes fossiles, la couche infratectale alvéolaire n'a pas été observée de plusieurs grains de pollen du genre de forme *Cycadopites* (TREVISAN, 1980, KEDVES, 1985, 1990a). Probablement la couche infratectale a été détruite au cours de la fossilisation. Mais il y a un grand nombre de publications concernant les grains de pollen ancien (*Praepollen*) avec une couche infratectale alvéolaire (tubulaire) qui est com-

parable aux *Cycadales*: citons les travaux de MILLAY et TAYLOR (1976), TAYLOR (1982), POORT, VISSCHER et DILCHER (1996).

Le but de notre travail est d'étudier la structure fine des grains de pollen dissous et dégradés partiellement en comparaison des résultats obtenus précédemment aux autres grains de pollen. Continuer des études sur la symétrie de biopolymères sur l'ectexine de ces grains de pollen. On a effectué cette méthode sur un pentagone régulier négatif.

Matière et méthode

Cycas circinalis L.

La matière des grains de pollen a été prélevée par Mons. I. SZÖLLŐSI du Jardin Botanique de l'Université J.A. de Szeged le 10 Avril, 1997. Les expériences de dissolution sont les suivantes ci-dessous:

Expériment No.: 1/7-811. - 5 mg grain de pollen + 5 ml H_2O + 0.2 ml diéthylamine.
Expériment No.: 1/7-812. - 5 mg grain de pollen + 5 ml H_2O + 0.2 ml mercaptoéthanol.
Expériment No.: 1/7-813. - 5 mg grain de pollen + 5 ml méthanol.
Expériment No.: 1/7-814. - 5 mg grain de pollen + 5 ml éthanol.
Expériment No.: 1/7-815. - 5 mg grain de pollen + 5 ml propanol.
Expériment No.: 1/7-816. - 5 mg grain de pollen + 5 ml alcool butylique.
Expériment No.: 1/7-817. - 5 mg grain de pollen + 5 ml i-alcool amylique.
Expériment No.: 1/7-818. - 5 mg grain de pollen + 5 ml glycérine 50%.
Température 30 C°, durée de dissolution 30 jours pour toutes les expériences.

Les échantillons de grains de pollen du genre *Encephalartos* et de *Ceratozamia mexicana* ont été mis à notre disposition par Mons. Dr. P. VORSTER (Institut botanique de l'Université de Stellenbosch, Afrique du Sud).

Numéro des expériences de la dégradation partielle:
1/7-1326 - 1/7-1331 *Encephalartos ferox* BERTOL.
1/7-1332 - 1/7-1337 *Ceratozamia mexicana* BRONGN.

Expérience No.: 1/7-1326 et 1/7-1332: 5 mg grain de pollen + 1 ml 2-aminoéthanol, température: 30 C° durée de la dégradation 24^h.

Expérience No.: 1/7-1327 et 1/7-1333: 5 mg grain de pollen + 1 ml 2-aminoéthanol, température: 30 C° durée de la dégradation: 48^h.

Expérience No.: 1/7-1328 et 1/7-1334: 5 mg grain de pollen + 1 ml 2-aminoéthanol, température: 30 C° durée de la dégradation: 72^h.

Expérience No.: 1/7-1329 et 1/7-1335: 5 mg grain de pollen + 1 ml 2-aminoéthanol, durée: 24^h, + 10 ml potassium permanganate 1%, durée: 24^h, température: 30 C°.

Expérience No.: 1/7-1330 et 1/7-1336: 5 mg grain de pollen + 1 ml 2-aminoéthanol, durée: 48^h, + 10 ml potassium permanganate 1%, durée: 24^h, température: 30 C°.

Expérience No.: 1/7-1331 et 1/7-1337: 5 mg grain de pollen + 1 ml 2-aminoéthanol, durée: 72^h, + 10 ml potassium permanganate 1%, durée: 24^h, température: 30 C°.

Chez les grains de pollen de *l'Encephalartos ferox* on a effectué l'expérience suivante:

No.: 183: 20 mg grain de pollen + 2 ml acide acétique anhydride durée 24^h + 1 ml 2-aminoéthanol durée: 24^h + 10 ml potassium permanganate 1% durée: 24^h, température: 30 C°. Dans ce cas on a utilisé la méthode de la rotation à un biopolymère négatif d'un pentagone régulier.

Pour les études au microscope électronique á transmission, la matière a été fixée par OsO_4 aq. dil. deshydratée et infiltrée dans l'Araldite. Les coupes ultraminces et les études au microscope électronique á transmission ont été faites dans le Laboratoire de Microscopie électronique de l'Institut biophysique du Centre biologique de l'Académie des Sciences de Hongrie. Le Tesla BS-540 (résolution 6-7 Å) et OPTON EM-902 electronmicroscope (résolution 2-3 Å) ont été utilisés.

Résultats

1. *Cycas circinalis* L. (Planche 12.1., figs. 1-5)

La figure 1 sur la Planche 1 représente la coupe transversale du grain de pollen dissous partiellement par diéthylamine. (Expérience No: 1/7-811). L'ectexine est résistante. On peut distinguer deux couches dans l'intine. La membrane cytoplasmique est dissoute, en général le protoplasme est abîmé. L'ectexine n'a pas apparemment changé au cours de la

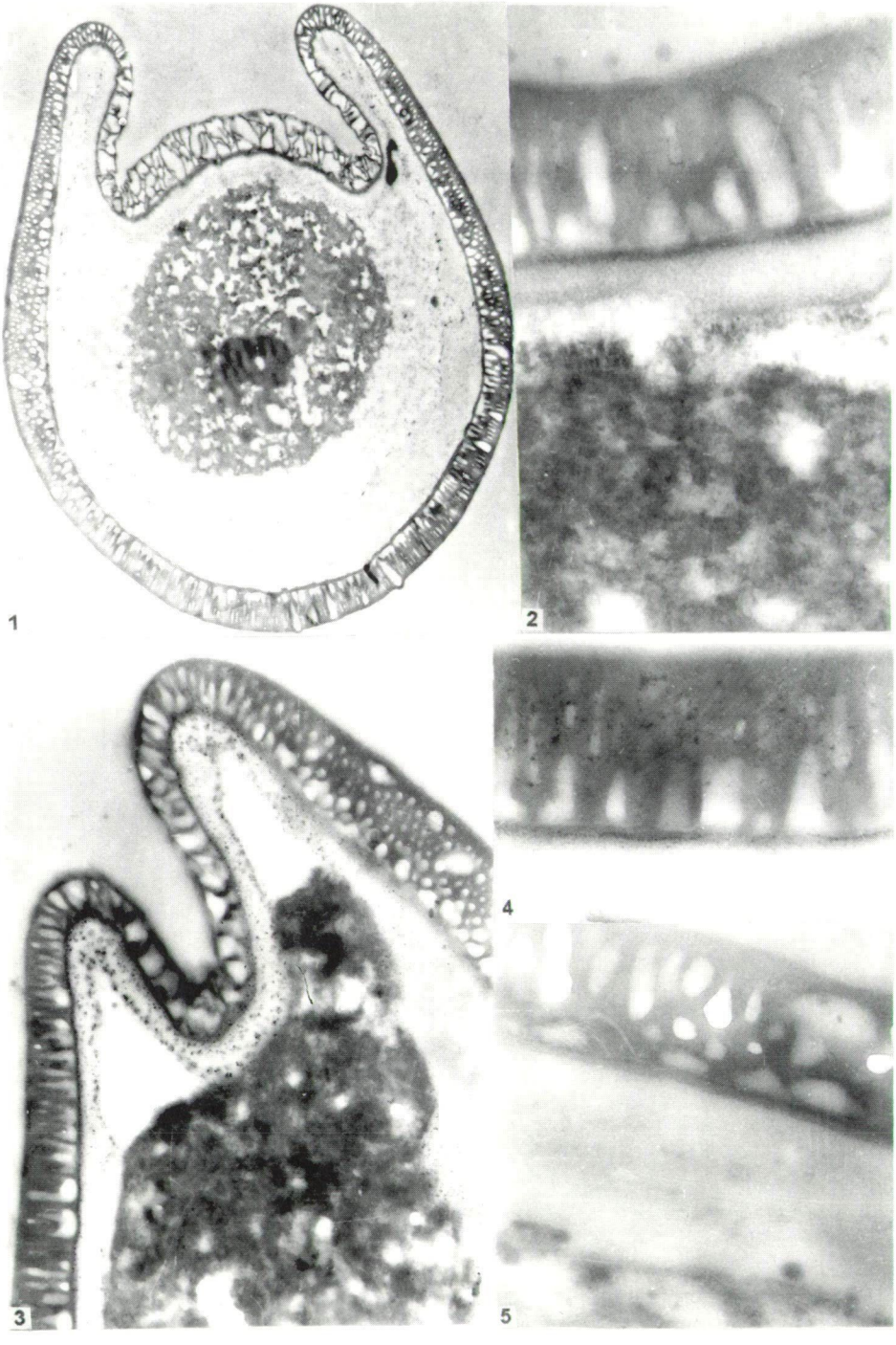


Planche 12.1.

Légende de la Planche 12.1.

1-5. - *Cycas circinalis* L.
1. - Aspect général de l'ultrastructure du coupe transversal du grain de pollen. No. de l'expérience: 1/7-811, numéro du négatif: 6713, x 5,400.
2. - Détail de l'ultrastructure du grain de pollen. No. de l'expérience: 1/7-812, numéro du négatif: 6726, x 36,000.
3. - Détail de l'ultrastructure de la région germinale. No. de l'expérience: 1/7-812, numéro du négatif: 6721, x 10,800.
4. - Détail de l'ultrastructure de l'ectexine. No. de l'expérience: 1/7-814, numéro du negatif: 6739, x 36,000.
5. - Détail de l'ultrasturcture de l'ectexine et du protoplasme. No. de l'expérience: 1/7-815, numéro du négatif: 6754, x 36,000.

---

dissolution par mercaptoéthanol (Planche 12.1., fig. 2). Mais la couche extérieure de l'intine est différente par contre, de l'expérience précédente, il y a des granules d'une affinité électronique forte. Les deux couches de l'intine sont délimitées par ces granules. La dégradation du protoplasme y compris la membrane cytoplasmique est aussi nette (Planche 12.1., fig. 3). Après la dissolution par méthanol des changements ont été observés dans les couches de l'intine et du protoplasme. L'alcool éthylique aussi n'a pas changé l'exine mais à l'intine les granules de la partie extérieure sont frappantes, et il y a une ligne de granules aussi à la limite de l'ectintine et l'endintine (Planche 12.1., fig. 4). Une dégradation remarquable a été observée dans le protoplasme. Il est à noter que la structure fine du protoplasme est la moins dégradée après dissolution par alcool propylique (Planche 12.1., fig. 5). L'alcool butylique et i-alcool amylique ont dégradé le protoplasme. Après la dissolution partielle par glycérine diluée l'ultrastructure cellulaire est plus ou moins bien conservée. La membrane cytoplasmique est nette, et les autres couches extérieures et le protoplasme aussi. Mais il est à noter que les organelles du cytoplasme ne sont pas en état bien explicites.

2. *Ceratozamia mexicana* BRONGN. (Planche 12.2., figs. 1,2)

Expérence No: 1/7-1332. - L'ectexine n'a pas dégradé seulement la sole détache nettement de la couche infratectale. L'intine et le protoplasme sont dégradés. Le résultat est approximativement le même chez les experiences No.: 1/7-1333 et 1/7-1334. La dégradation a découvert le système de biopolymère de la sporopollenine chez les expériences à partir du 1/7-1335. La dégradation par l'expérience 1/7-1336 est figurée sur la fig. 1 de la Planche 12.2. Une partie de la couche infratectale est représentée. Plusieurs sortes de structures des molécules sont mis en évidence. Parmi celles-ci il y a des structures linéaires orientées plus ou moins radialement, qui peuvent être des systèmes hélicoïdaux. Ensuite il y a lieu de mentionner les systèmes moléculaires sensu stricto: parmi ceux-ci il y a des molécules cycliques des pentagones et hexagones réguliers aussi. La fig. 2 de la Planche 12.2. représente un aperçu général du grain de pollen fort dégradé (expérience No.: 1/7-1337). Il y a des résidus de l'ectexine quelques part; la sole est aussi complètement détruite, le protoplasme et l'intine sont homogènes. A haut grossissement, une dégradation du système de biopolymère a été aussi observée.

3. *Encephalartos ferox* BERTOL. (Planche 12.2., figs. 3-9)

3.1. Dégradation partielle des grains de pollen (Planche 12.2., figs. 3-8)

Les expériences 1/7-1326 - 1/7-1328 n'ont pas découvert le système de biopolymère de l'ectexine. Par exemple la photo 3 de la Planche 12.2. illustre une partie de l'ultrastructure de la région germinale du grain de pollen. La structure fine de l'intine est nette. L'aspect général de la région aperturale est représenté sur la photo 4 de la Planche 12.2.,

suivant l'expérience 1/7-1326. La partie intérieure de l'intine est gonflée. La partie extérieure de l'ectintine est mince, et avec une affinité électronique forte. Il y a encore une autre partie de l'ectintine, comme cela on peut distinguer trois couches après ce processus de dégradation. A haut grossissement (Planche 12.2., fig. 5) une dégradation particulière a été observée. On peut distinguer deux couches fort dégradées à la partie extérieure du tectum. Ici les unités du système biopolymère sont frappantes. La plus grande partie du tectum semblait plus ou moins homogène. Mais la couche infratectale est bien dégradée, l'expérience a bien découvert le système de biopolymère du sporopollenine. L'expérience suivante (1/7-1330) a aussi bien découvert le système de biopolymère. La photo 6 sur la Planche 12.2. représente la structure moléculaire de l'infratectum. Ce système est ressemblant ou identique à celui que nous avons démontré précédemment chez la couche infratectale du *Ceratozamia mexicana* (Planche 12.2., fig. 1). Au grossissement du 3,6 millions la structure des molécules sensu strictu est bien observable. Nous présentons un amas de molécules cycliques. Finalement nous publions l'aperçu général de l'ultrastructure du grain de pollen dégradé. Il y a lieu de remerquer que les couches différentes de l'intine sont bien distinctes. L'expérience 1/7-1331 a abîmé partiellement les unités de biopolymère de l'ectexine.

3.2. Études de la symétrie de biopolymère d'un pentagone régulier clair du tectum dégradé partiellement par l'expérience No.: 183 (Planche 12.2., fig. 9).

Dans les travaux antérieurs nous avons utilisé des unités de biopolymères dits positifs, sauf une fois pour la paroi dégradée partiellement *d'Equisetum arvense* (KEDVES et PÁRDUTZ, 1993). Maintenant nous avons découvert le système de biopolymère de l'ectexine et nous avons choisi un pentagone régulier clair pour les opérations de symétrie. Il est fort probable que dans ce cas-là il s'agit d'une biopolymère dégradée, et le cavité a gardé la structure originelle.

Nous avons effectué quatre sortes de rotation suivant les méthodes décrites dans l'étude de KEDVES (1989). Mentionnons encore quelques travaux qui sont importants dans la méthode de l'étude de la symétrie de biopolymère; KEDVES (1990b, 1991), KEDVES, TÓTH et FARKAS (1993).

Résultats:

C.P.5.A.5.5.

Un pentagone régulier clair est apparu entouré d'une zone pentagonale bien limitée.

Autour de cette zone il y en a une autre claire composée de structures de biopolymère des unités cycliques qui peuvent être des pentagones. Cette zone de rotation est entourée d'une partie foncée mais partiellement des autres zones claires sont apparues en conséquence de cette rotation.

C.P.5.B.5.5.

Le résultat de cette rotation est inattendu, étant donné qu'un système de Penrose négatif est apparu. Au milieu aussi il y a un pentagone régulier clair entouré de cinq unités claires. Ensuite ce système est entouré de cinq autres unités qui peuvent être représentées entièrement avec un système de Penrose clair. Ce système est entouré avec d'une zone obscure, mais des parties des autres systèmes clairs sont apparus autour cette zone.

C.P.5.A.5.10.

Ce résultat aussi est intéressant. Une zone claire est apparue avec plusieurs points de symétrie secondaire claire. Mais autour de cette zone il y a 10 points de symétrie noirs au bord de la zone de rotation claire. Cette rotation a résulté de plusieurs cercles (environ cinq) autour du centre qui peuvent être utiles pour les rotations secondaires.

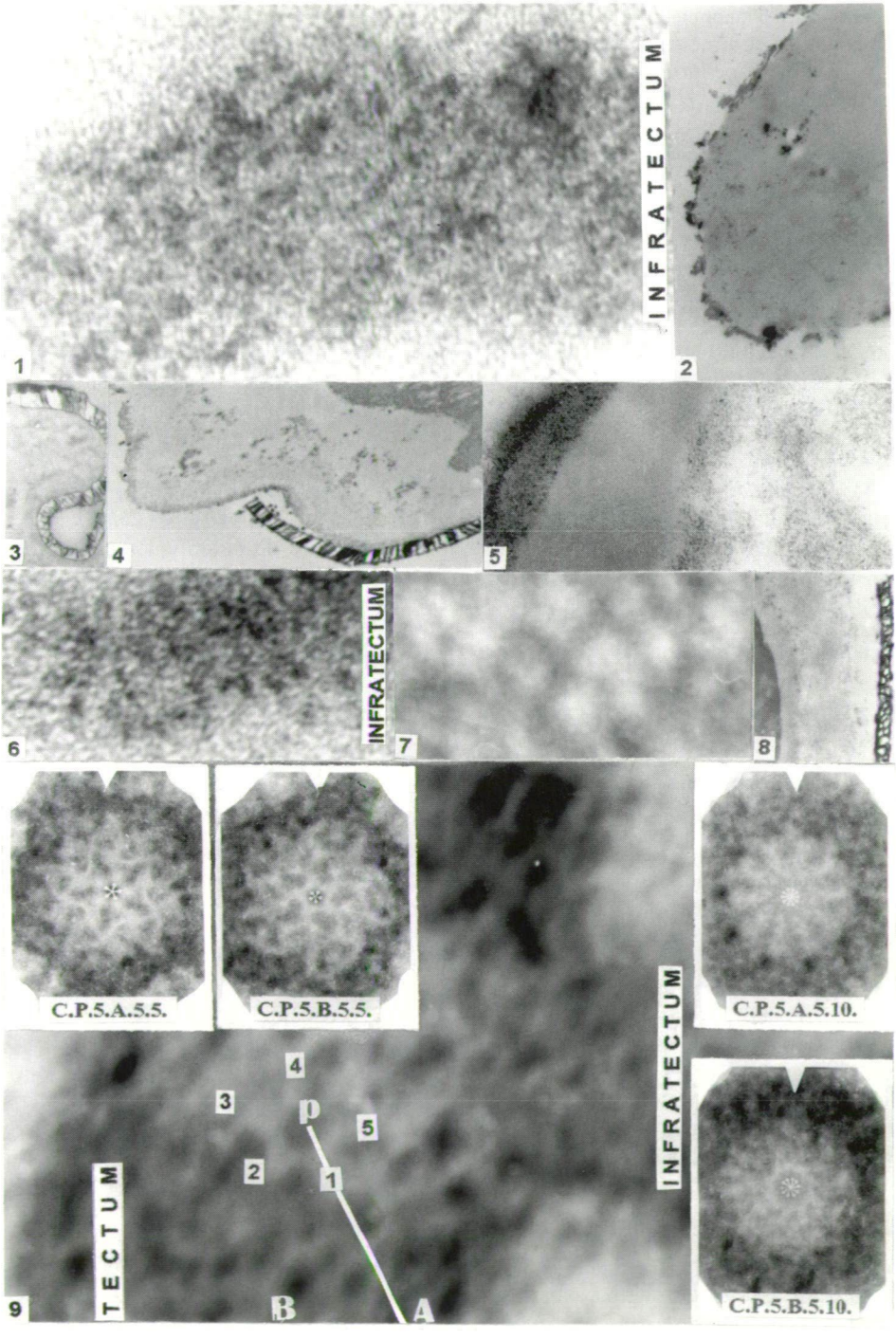

1
INFRATECTUM
2
3
4
5
6
INFRATECTUM
7
8
C.P.5.A.5.5.
C.P.5.B.5.5.
C.P.5.A.5.10.
INFRATECTUM
4
3
p
5
2
1
TECTUM
9
B
A
C.P.5.B.5.10.

Planche 12.2.

Légende de la Planche 12.2.

1,2. - *Ceratozamia mexicana* BRONGN.

1. - La structure de biopolymère de la couche infratectale dégradée partiellement. No. de l'expérience: 1/7-1336, numéro du négatif: 7426, x 719,800.
2. - Aspect général du grain de pollen dégradé partiellement. La dégradation de l'ectexine est frappant. No. de l'expérience: 1/7-1337, numéro du négatif: 7275, x 3,600.

3-9. - *Encephalartos ferox* BERTOL.

3. - Aspect général de l'ultrastructure de la région germinale. No. de l'expérience: 1/7-1326, numéro du négatif: 7025, x 3,600.
4. - Protrusion de l'intine et du protoplasme. No. de l'expérience: 1/7-1329, numéro du negatif: 7270, x 3,600.
5. - La structure de biopolymère du tectum et de la couche infratectale. No. de l'expérience: 1/7-1329, numéro du négatif: 7431, x 108,000.
6. - Détail de la structure de biopolymère de la couche infratectale. No. de l'expérience: 1/7-1330, numéro du négatif: 7422,x 719,800.
7. - Molecular structure cyclique de la couche infratectale. No. de l'expérience: 1/7-1330, numéro du négatif: 7422, x 3,600.000.
8. - Détail de l'exine et du protoplasme dégradée partiellement. No. de l'expérience. 1/7-1331, numéro du négatif: 7217, x 3,600.
9. - Détail du tectum et de la couche infratectale dégradée partiellement, avec les résultats des rotations différentes. No. de l'expérience: 183, numéro du négatif: 8026, x 899,800.

C.P.5.B.5.10.

En conséquence de cette rotation il y a aussi une zone claire avec beaucoup de cercles des points de symétrie claires et sombres, mais il n'y a pas autour de cette zone un cercle caractéristique avec des points de symétrie obscures.

Commentaires et Conclusions

1. La dissolution partielle des grains de pollen de *Cycas circinalis* a confirmé une résistance remarquable du système de biopolymère de la paroi externe du grain de pollen. On peut remarquer les altérations de l'intine, la destruction de la membrane cytoplasmique et des organelles du protoplasme. Par contre avec nos expériences sur les grains de pollen de *Platanus hybrida* la dissolution avec la glycérine diluée n'a pas mis en évidence les organelles cytoplasmiques.

2. Les expériences de la dégradation partielle ont découvert le système des biopolymères de l'ectexine des espèces de *Ceratozamia mexicana* et *Encephalartos ferox*. On a mis en évidence plusieurs sortes de systèmes de biopolymère; parmi ceux-ci les systèmes linéaires qui peuvent être aussi des organisations hélicoïdales sont à mentionner. En ce qui concerne la dégradation partielle de *l'Encephalartos ferox* un phénomene particulier a été observé. La partie extérieure du tectum et la couche infratectale ont été dégradées suffisamment pour l'étude des organisations différentes des structures de biopolymères. Jusqu'ici et aux premiers résultats (KEDVES, STANLEY et ROJIK, 1974) nous avons établi que la couche infratectale peut être dégradée le plus aisémenet par les influences expérimentales ou naturelles (au cours des influences de sédimentation). Au haut grossissement nous avons mis en évidence plusieurs sortes de molécules, il y a des molécules cycliques, et dans le futur on va effectuer des rotations moléculaires sur ces unités.

3. Les résultats des rotations sont inattandus, en particulier lorsqu'on a obtenu le système de Penrose négatif en conséquence d'une rotation primaire de l'extinction (B).

En ce qui concerne le grand nombre des points de symétrie qui sont apparus après les rotations primaires il y a la possibilité de plusieurs sortes de rotations sécondaires.

Remerciements

Ces recherches ont été effectuées par le concours du Crédit de l'OTKA, T 031715.

Bibliographie

AFZELIUS, B.M. (1956): Electron microscope investigations into exine stratification. - Grana Palynologica *1*, 22-37.

AUDRAN, J.C. (1970): Sur l'ultrastructure de la paroi pollinique chez le *Ceratozamia mexicana (Cycadacées).* - Pollen et Spores 12, 485-511.

AUDRAN, J.C. (1974): Aspects ultrastructuraux de l'individualisation des microspores du *Ceratozamia mexicana (Cycadacées).* - C.R. Acad. Sc. Paris *278*, 1023-1026.

AUDRAN, J.C. (1978a): Présentation de quelques transformations structurales et texturales des exines de *Cycadales* traitées par l'acétolyse, puis fixées par le permanganate de potassium. - Ann. des Mines de Belgique *2*, 133-141.

AUDRAN, J.C. (1978b): Cytobiologie de la microsporogenese de la palynogenèse et du tapis chez *Ceratozamia mexicana (Cycadacées).* - Ann. Univ. A.R.E.R.S., Reims 1978, *16*, 1-26.

AUDRAN, J.C. (1979a): Activité tonoplastique et fragmentation de la vacuole dans la microspore du *Ceratozamia mexicana (Cycadaceae, Préspermaphyte).* - Rev. Cytol. Biol. végét. - Bot. 1979 *2*, 7-11.

AUDRAN, J.C. (1979b): Microspores, pollen grains and tapetum ontogeny in *Ceratozamia mexicana (Cycadaceae)*: An ultrastructural study. - Phytomorphology *29*, 350-362.

AUDRAN, J.C. (1980): Morphogenèse et altérations provoquées des exines des *Cycadales* apports à une meilleure interprétation de leur infrastructure. - Rev. Cytol. Biol. végét. - Bot. *3*, 311-353.

AUDRAN, J.C. (1981): Pollen and tapetum development in *Ceratozamia mexicana (Cycadacéeae)*: Sporal origin of the exinic sporopollenin in cycads. - Rev. Palaeobot. Palynol. *33*, 315-345.

AUDRAN, J.C. et MASURE, E. (1976): Précisions sur l'importance de l'exine chez les *Cycadales (Prespermaphytes).* - Pollen et Spores *18*, 5-26.

AUDRAN, J.C. et MASURE, E. (1977): Contribution à la connaissance de la composition des sporodermes chez les *Cycadales (Prespermaphytes).* Étude au microscope électronique à transmission (M.E.T.) et à balayage (M.E.B.). - Palaeontographica B, 162, 115-158.

AUDRAN, J.C. et MASURE, E. (1978): La sculpture et l'infrastructure du sporoderme de *Ginkgo biloba* comparées à celles des enveloppes polliniques des *Cycadales*. - Rev. Palaeobot. Palynol. *26*, 363-387.

ERDTMAN, G. and DUNBAR, A. (1969): On the fine structure of the exine in *Macrozamia reidli.* - Bot. Soc. Senegal, J. SEN Memorial vol. 179-189.

GULLVÅG, B. (1966): The fine structure of some gymnosperm pollen walls. - Grana Palynologica *6*, 435-475.

KEDVES, M. (1985): Structural modification of degraded fossil sporomorphs. - Micropaleontology *31*, 173-178.

KEDVES, M. (1989): Méthode d'étude des biopolymères de la paroi pollinique à structure quasi-cristalloïde. A method of investigation of the quasi-crystalloid structure of the wall biopolymers. - Rev. de Micropaléontologie *32*, 226-234.

KEDVES, M. (1990a): Palynological studies on manganese ore layers in Úrkút (Transdanubia), Hungary. - Ore Geol. Rev. *5*, 491-507.

KEDVES, M. (1990b): Quasi-crystalloid basic molecular structure of the sporoderm. - Rev, Palaeobot. Palynol. *64*, 181-186.

KEDVES, M. (1991): First observations on the biopolymer organization of the intine. - Plant Cell Biology and Development (Szeged) *1*, 15-27.

KEDVES, M. (1994): Transmission electron microscopy of the fossil gymnosperm exines. - Szeged.

KEDVES, M. and PÁRDUTZ, Á. (1993): Negative quasi-crystalloid biopolymer network from the exospore of *Equisetum arvense* L. - Plant Cell Biology and Development (Szeged), *4*, 78-80.

KEDVES, M., STANLEY, E.A. et ROJIK, I. (1974): Observations nouvelles sur l'ectexine des pollens fossiles des Angiospermes de l'Eocène inférieur. - Pollen et Spores *16*, 425-437.

KEDVES, M., TÓTH, A. and FARKAS, E. (1993): An experimental investigation of the biopolymer organization of both recent and fossil sporoderms. - Grana Suppl. *1*, 40-48.

MILLAY, M.A. and TAYLOR, T.N. (1976): Evolutionary trends in fossil gymnosperm pollen. - Rev. Palaeobot. Palynol. *21*, 65-71.

PETTITT, J.M. (1966): Exine structures in some fossil and recent spores and pollen as revealed by light and electron microscopy. - Bull. of the British Museum (Nat. Hist.) Geology *13*, 221-257.

POORT, R.J., VISSCHER, H. and DILCHER, D.L. (1996): Zoidogamy in fossil gymnosperms: The centenary of a concept, with special reference to prepollen of late Paleozoic. - Proc. Natl. Acad. Sci. USA *93*, 11713-11714.

ROWLEY, J.R. (1978): A model of exine substructure. - Eleventh Ann. Meeting AASP, Phoenix, Arizona, Abstracts, 31-32.

ROWLEY, J.R., DAHL, A.O. and ROWLEY, J.S. (1981): Substructure in exine of *Artemisia vulgaris (Asteraceae)*. - Rev. Palaeobot. Palynol. *35*, 1-38.

SKVARLA, J.J. and ROWLEY, J.R. (1970): The pollen wall of *Canna* and its similarity to the germinal apertures of other pollen. - Amer. J. Bot. *57*, 519-529.

TAYLOR, T.N. (1982): Ultrastructural studies of paleozoic seed fern sporoderm development. - Rev. Palaeobot. Palynol. *37*, 29-53.

TREVISAN, L. (1980): Ultrastructural notes and considerations on *Ephedripites, Eucommiidites* and *Monosulcites* pollen grains from Lower Cretaceous sediments of Southern Tuscany (Italy). - Pollen et Spores *22*, 85-132.

UENO, J. (1960): On the fine structure of the cell walls of some gymnosperm pollen. - Biol. J. Nara Women's University *10*, 19-25.

WANG FU-HSIUNG (1990): Microsporogenesis in cycads and *Ginkgo*. - Microspores Evolution and Ontogeny, Academic Press, 147-155.

WITTBORN, J., RAO, A.R., EL-GHAZALY, G. and ROWLEY, J.R. (1998): Nanoscale Similarities in the Substructure of the Exines of Fagus Pollen Grains and *Lycopodium* Spores. - Annals of Botany *82*, 141-145.

XI, YI-ZHEN (1990): Ultrastructure of exine of *Cycas panzhihuanensis* and *Ginkgo biloba*. - Yushania *7*, 81-90.

XI, YI-ZHEN and WANG FU-HSIUNG (1989): Pollen exine ultrastructure of extant Chinese gymnosperms. - Cathaya *1*, 119-142.

ZAVADA, M.S. (1983): Pollen wall development of *Zamia floridiana*. - Pollen et Spores *25*, 287-304.

13. LIST OF PUBLICATIONS OF THE LABORATORY UNTIL DECEMBER 2000

Compiled by

D. TOMBÁCZ

Cell Biological and Evolutionary Micropalontological Laboratory of the University of Szeged, H-6701, P.O. Box 993, Szeged, Hungary

ALVAREZ RAMIS, C. (2000): Comentarios acerca de las investigaciones conjuntas entre el laboratorio de paleobotánica del Departamento de Paleontologia (UCM) / UEI de Paleontologia del Instituto de Geologia Económica (CSIC) de Madrid y el Cell Biological and Evolutionary Micropaleontological Laboratory de Szeged. - Plant Cell Biology and Development (Szeged) *12*, 7.

ALVAREZ RAMIS, C., LAAMARTI, N. and VEGAS, J. (2000): A preliminary palynological study of epiclastic deposits from "Caldera de Taburiente". La Palma Island, Canary Archipelago, Spain. Estudio palinologico preliminar de depósitos epiclasticos procedentes de la Caldera de Taburiente. Isla de la Palma, Canarias. - Plant Cell Biology and Development (Szeged) *11*, 50-57.

DEJAX, J. et SALARD-CHEBOLDAEFF, M. (2000): In memoriam EUGÈNE BOLTENHAGEN (1906-1999). - Plant Cell Biology and Development (Szeged) *11*, 207-208.

KEDVES, M. (2000a): Organic microfossils from Hungarian Cretaceous sediments. - Plant Cell Biology and Development (Szeged) *11*, 19-33.

KEDVES, M. (2000b): Upper Cretaceous pollen grains from Egypt IV. - Plant Cell Biology and Development (Szeged) *11*, 34-49.

KEDVES, M. (2000c): Palynological investigations on Hungarian Neogene lignites. – Plant Cell Biology and Development (Szeged) *11*, 58-78.

KEDVES, M., ALVAREZ RAMIS, C., FERNÁNDEZ MARRÓN, M.-T., CLEMENTE BELMONTE, P. and GOMEZ PORTER, P. (1999): Sporomorphs isolated from pre-Quaternary sediments of "Barranco de Patones" (Spain). - Ann. Univ. Sci. Budapestinensis, Sect. Geol. *32*, 57-71.

KEDVES, M. and BORBOLA, A. (2000): Transmission electron microscopy of partially dissolved exines of *Pseudotsuga menziesii* (MIRB.) FRANCO. - Plant Cell Biology and Development (Szeged) *11*, 193-198.

KEDVES, M., BORBOLA, A., TRIPATHI, S.K.M. and MADHAV KUMAR (2000a): Thermal effect on some extant palm pollen. - Plant Cell Biology and Development (Szeged) *11*, 166-183.

KEDVES, M., BORBOLA, A., TRIPATHI, S.K.M. and MADHAV KUMAR (2000b): Transmission electron microscopic studies on partially degraded pollen grains of *Phoenix sylvestris* LINN. - Plant Cell Biology and Development (Szeged) *12*, 93-103.

KEDVES, M., BORSODI, A., DOBÓ, K., KOVÁCS, E. and SZÉCSÉNYI, A. (1999): L'effect de l'hydratation sur les grains de pollen des *Cycadales*. Hydratation effect on *Cycadales* pollen grains. - Geo - Eco - Trop Actes du 4 ème Symposium de Palynologie Africaine Proceedings of the 4 th Symposium on African Palynology Sousse (Tunisie), 25-30/04/1999, 227-234.

KEDVES, M. and HORVÁTH ERIKA (2000): LM and TEM investigations of partially dissolved and degraded pollen grains of *Elaeagnus angustifolia* L. - Plant Cell Biology and Development (Szeged) *11*, 150-154.

KEDVES, M., HORVÁTH ESZTER, TERBE, ZS. and TOMBÁCZ, D. (2000): High temperature effect of the pollen grains of *Buxus sempervirens* L. - Plant Cell Biology and Development (Szeged) *11*, 161-165.

KEDVES, M. and KÁROSSY, Á. (2000): LM investigations on partially dissolved sporomorphs IV. - Plant Cell Biology and Development (Szeged) *11*, 141-149.

KEDVES, M. and MADARÁSZ, M. (2000a): Experimental investigations on the pollen grains of *Punica granatum* L. - Plant Cell Biology and Development (Szeged) *11*, 121-127.

KEDVES, M. and MADARÁSZ, M. (2000b): Transmission electron microscopy on partially degraded Paleocene pollen grains. - Abstracts 10th International Palynological Congress, June 24-30, 2000, Nanjing, China (eds.: WANG WEIMING, OUYANG SHU, SUN XIANGJUN and YU GE) 79-80.

KEDVES, M. and MADARÁSZ, M. (2000c): Transmission electron microscopy of the partially degraded pollen grains from the Thanetian layers of Menat (France) I. - Plant Cell Biology and Development (Szeged) *12*, 40-62.

KEDVES, M., MADARÁSZ, M., SZÉCSÉNYI, A., HORVÁTH, A., TERBE, ZS., HORVÁTH ESZTER, BORSODI, A., DOBÓ, K., KOVÁCS, E. and KANCSÁR, T. (2000): Duhoux effect on inaperturate *gymnosperm* and *angiosperm* pollen grains. - Plant Cell Biology and Development (Szeged) *11*, 128-140.

KEDVES, M. and PÁRDUTZ, Á. (1999): Experimental investigations of the pollen grains of *Welwitschia mirabilis* HOOK. In: K. HAINE ed., and L. SCOTT, A. CADMAN and R. VERHOEVEN guest-eds.: Palaeoecology of Africa and the surrounding Islands. Proceedings of the Third Conference on African Palynology, Johannesburg, 14-19 September 1997, 249-252, Balkema/Rotterdam/Brookfield.

KEDVES, M. and PÁRDUTZ, Á. (2000a): Transmission electron microscopy of Hungarian Tertiary lignites II. - Plant Cell Biology and Development (Szeged) *11*, 99-106.

KEDVES, M. and PÁRDUTZ, Á. (2000b): Chloroplast thylakoid membranes in the intine of ragweed pollen grains as a possible constituent in the biosynthesis of its extreme allergenic antigens. - Plant Cell Biology and Development (Szeged) *12*, 87-92.

KEDVES, M., PÁRDUTZ, Á. and MADARÁSZ, M. (2000): New data on the molecular symmetry and organization of the quasi-crystalloid skeleton of the sporoderm. - Plant Cell Biology and Development (Szeged) *11*, 184-192.

KEDVES, M., PÁRDUTZ, Á., MADARÁSZ, M., TOMBÁCZ, D., HORVÁTH, A., SZÉCSÉNYI, A., SASHALMI, J., TERBE, ZS., HORVÁTH ESZTER and KOVÁCS, E. (2000): LM, SEM and TEM investigations on partially degraded *Botryococcus braunii* KÜTZ. colonies from Hungarian Upper Tertiary oil shale I. - Plant Cell Biology and Development (Szeged) *12*, 63-86.

KEDVES, M., SASHALMI, J. and TOMBÁCZ, D. (2000a): LM, SEM and TEM Investigations on the biopolymer structure of *Botryococcus braunii* isolated from Hungarian oil shale. - Abstracts 10th International Palynological Congress June 24-30, 2000, Nanjing, China (eds.: WANG WEIMING, OUYANG SHU, SUN XIANGJUN and YU GE), 80.

KEDVES, M., SASHALMI, J. and TOMBÁCZ, D. (2000b): Upper Cretaceous pollen grains from Egypt V. - Plant Cell Biology and Development (Szeged) *12*, 18-29.

KEDVES, M., SZÓNOKY, M. and GULYÁS, S. (2000): Combined investigations on Hungarian Neogene lignites. - Plant Cell Biology and Development (Szeged) *11*, 79-98.

KEDVES, M., SZÓNOKY, M., MADARÁSZ, M. and KOVÁCS, G. (2000): LM and TEM investigations on the Upper Cretaceous Ajkaite, of Hungary I. - Plant Cell Biology and Development *12*, 8-17.

KEDVES, M., TERBE, ZS., HORVÁTH ESZTER and SASHALMI, J. (2000): High temperature effect on monolete fern spores. - Plant Cell Biology and Development (Szeged) *11*, 155-160.

KVAVADZE, E., KEDVES, M., MADARÁSZ, M. and HORVÁTH, A. (2000): Redeposited sporomorphs from Holocene lake sediments of Caucasus. - Plant Cell Biology and Development (Szeged) *11*, 107-120.

LAGOS, J.A., KEDVES, M. y HORVÁTH ERIKA (2000): Investigaciones experimentales de los granos de polen de *Tecoma stans* (L.) H.B.K. - Plant Cell Biology and Development (Szeged) *11*, 199-205.

MADARÁSZ, M. and HORVÁTH ANDREA (2000): List of publications of the Laboratory until December 1999. - Plant Cell Biology and Development (Szeged) *11*, 206.

PRAMOD KUMAR (2000): Palynodating of Denwa Formation, Satpura Basin, India. - Plant Cell Biology and Development (Szeged) *11*, 9-18.

TERBE, Zs. (2000): Chronicle. - Plant Cell Biology and Development (Szeged) *11*, 209-213.

YOUSSEF, S.G.M., EL-SAADAWI, W.E., KEDVES, M. and MOSTAFA, R.M. (2000): Wood anatomy of a silicified trunk from the Kharga Oasis, Egypt. - Plant Cell Biology and Development (Szeged) *12*, 30-39.

Chronicle

compiled by

A. SZÉCSÉNYI

Visiting scientists

Prof. Dr. C. ALVAREZ RAMIS (Universidad Complutense, Madrid, Spain) from 20 to 23 August visited the Laboratory. Fruitful scientific discussions were carried out on the Upper Cretaceous Palynology. Planning of further joint research programs were discussed.

International Laboratory activities

13 - 21 February, 2000, Lucknow, Uttar Pradesh, India.

Prof. Dr. M. KEDVES in the Birbal Sahni Institute of Palaeobotany finished the manuscript of a new paper (KEDVES, M., HORVÁTH, A., TRIPATHI, S.K.M. and MADHAV KUMAR: Symmetry operations on the quasi-crystalloid biopolymer system of the sporopollenin of *Phoenix sylvestris* LINN. from India), which appeared in this volume. On the18th February at 4 p.m. a party was organized by the Institute to award Dr. S.K.M. TRIPATHI and MADHAV KUMAR. In his opening delivery Dr. A.K. SINHA, professor, Director of the Institute appreciated the results of the Hungarian Scientist in India, and the cooperation of the B.S. Institute with the C.B.E.M. Laboratory. He presented the new number of Plant Cell Biology and Development (Plate 1., fig. 1). Prof. Dr. M. KEDVES, Dr. S.K.M. TRIPATHI and Dr. MADHAV KUMAR emphasized the advantages of the scientific cooperation for both sides. After that the Commemorative Medal of the Laboratory was handed over to Dr. S.K.M. TRIPATHI (Plate 1., fig. 2), and the Diploma of the Laboratory to Dr. MADHAV KUMAR (Plate 1., fig. 3).

22 June - 1 July, 2000, Nanjing, China

The 10. International Palynological Congress was held in Nanjing.

Organizing Committee:

President: SONG ZHICHEN, DAVIS Owen, K. Vice President: GAO RUIQI, WANG KAIFA, SUN XIANGJUN, XING YUSHENG, TANG LINGYU. Secretary-General: LIU GENGWU. Vice Secretary-General: ZHAO CHUANBEN, YIN CHONGYU, ZHU HUAICHENG, WANG WEIMING. Secretariat Office: ZHU HUAICHENG, YANG WEIPING, LI JIANGUO. Treasurer: ZHU ZONGHAO, HUANG FEI. Scientific Programme: WANG WEIMING, OUYANG SHU, SUN XIANGJUN, YU GE. Field Trips: YIN CHONGYU, GAO LINZHI, WANG XINFU. On June 25, 2000 the invited lectures were presented in the Purple Ballroom. Chairpersons: Annick LE THOMAS and LIU GENGWU

09.00-09.40 CHEN JUNYUAN: The dawn of the animal diversity.

09.40-10.20 M. KEDVES: Trends and new aspects of the basic and applied palynology.

10.20-10.50 Coffee Break.

10.50-11.30 Owen DAVIS: Long terrestrial records of climate and vegetation change from Western North America.

On June 30, 2000 in the Cenozoic Palynology (Chairpersons: M. KEDVES and WANG WEIMING) the following papers were presented by M. KEDVES:

Plate 1.

M. KEDVES and M. MADARÁSZ: Transmission electron microscopy on partially degraded Paleocene pollen grains.

M. KEDVES, J. SASHALMI and D. TOMBÁCZ: LM, SEM and TEM investigations on the biopolymer structure of *Botryococcus braunii* isolated from Hungarian oil shale.

From 11-15 October Prof. Dr. M. KEDVES visited the Department of Paleontology of the Universidad Complutense de Madrid. The further joint researches were discussed in detail. On October 13 he delivered the following paper: Les anomalies paléobotaniques trouvés dans les successions lithologiques de Patones".

Hungarian scientific activities

On the 19th January appeared the 11th number of Plant Cell Biology and Development, followed this by the 12th one on the 21th July.

The 1362th meeting of the Botanical Section of the Hungarian Biological Society was held on May 15 M. KEDVES delivered the following lecture: KEDVES M., MADARÁSZ, M., SASHALMI J. and TOMBÁCZ, D.: Komplex (LM, TEM, SEM) vizsgálatok parciálisan degradált növényi mikrofossziliákon. Complex (LM, TEM, SEM) investigations on partially degraded plant microfossils.

Laboratory meetings and news

29.01.2000.
The state of the Laboratory publications, the program of the Laboratory meetings and the contributions in international research programs. Speaker: M. KEDVES.
Diapositive projections from India (Lucknow).

26.02.2000.
Report from the visit in the Birbal Sahni Institute of M. KEDVES. Other businesses, speaker: M. KEDVES. Diapositive projections from Japan, Yokohama.

25.03.2000.
The present day position of the Laboratory publications. Contributions of the students in the international scientific programs. Speaker: M. KEDVES. Diapositive projections: spores and pollen grains.

29.04.2000.
Report from the meeting on the 20th April about the Geonomical Committee of the Hungarian Academy of Sciences and the obligations of the Laboratory concerning this project. Speaker: M. KEDVES. Diapositive projections: spores and pollen grains, U.S.A, Sequoia woodland, California and Everglades, Florida-1.

27.05.2000.
Experimental studies on the teliospores of *Ustilago maydis*. Speaker: A. BORBOLA.
Present day problems of the Laboratory, speaker: M. KEDVES. Diapositive projections: spores and pollen grains, U.S.A., Sequoia woodland, California and Everglades, Florida-2.

08.07.2000.
Report from the 10th International Palynological Congress, (Nanjing, China), speaker: M. KEDVES. The research programs of the Laboratory for the summer, the publications of the Laboratory. Other businesses.

21.08.2000.
At 4 hour p.m. an exclusive reception took place in the Laboratory. The 10th Anniversary of the Laboratory was appreciated. The Millennium Medal of the Laboratory

Plate 2.

was handed over to Prof. Dr. C. ALVAREZ RAMIS (Plate 2., figs. 1,4,5). Participation from the Laboratory: A. BORBOLA (Plate 2., figs. 3,5), , Prof. Dr. M. KEDVES (Plate 2., figs. 1,4,5), M. MADARÁSZ (Plate 2., figs. 4,5), K. PRISKIN (Plate 2., figs. 1,5), J. SASHALMI (Plate 2., fig. 5), V. SIPOS (Plate 2., fig.4), A. SZÉCSÉNYI (Plate 2., fig. 5), D. TOMBÁCZ (Plate 2., fig. 2).

26.08.2000.

The research programs of the Laboratory until the end of this year.

01.09.2000.

The following middle-school students started the work in the Laboratory: J. BANGÓ, B. GÉGÉNY, E. HAJNAL, ZS. IMRE, I. JÓJÁRT, T. KRIZSÁN, P. LUKÁCS, G. SCHULZ and T. SZÉL. M. MADARÁSZ would like to continue her university studies, so she left the Laboratory as an assistant, however she is includied in the OTKA research program and she continues her scientfic work in the Laboratory. Miss K. FREY started working as an assistant in the Laboratory.

23.09.2000.

The present day state of the research programs of the Laboratory, speaker: M. KEDVES. Diapositive projections from spores and pollen grains.

21.10.2000.

Report from the visit in the Paleontological Institute of the "Universidad Complutense" in Madrid, speaker: M. KEDVES. A. Borbola presented the program of her diploma work.

Diapositive projections.

25.11.2000.

Discussion of the papers for publication in the 14th number of Plant Cell Biology and Development, speaker M. KEDVES. Diapositve projections.

16.12.2000.

The scientific programs and the international obligations of the Laboratory during the first half of 2001, speaker: M. KEDVES. Other businesses. Diapositive projections.

Teaching program of the Laboratory

In the year of 2000 the following lectures were delivered:

1. Introduction to the prequaternary Palynology-1 Ph.D. course, 1 + 2
2. Applied Palynology, 1 + 2
3. Biopolymer organization and symmetry, 1 + 0
4. Theory of Evolution and Natural Phylosophy, 1 + 0
5. Basic Palynology, 1 + 2
6. Theory of the Supernova, 1 + 0

Plate 1.

1. - Prof. Dr. A.K. SINHA, Director of the Birbal Sahni Institute present the 11th number of Plant Cell Biology and Development at the party of the Institute on the 18 February 2000. 2.- Dr. S.K.M. TRIPATHI with the Commemoratrive Medal of the Laboratory.
3.- Prof. Dr. M. KEDVES (left) hands over the Laboratory Diploma to Dr. Madhav Kumar (right). In the middle: Prof. Dr. A.K. SINHA, Director of the Birbal Sahni Institute of Palaeobotany.

Plate 2.

1. - Prof. Dr. C. ALVAREZ RAMIS takes over the Millennium Medal and the Declaration of the Laboratory. Right K. PRISKIN middle-school student. 2. - D. TOMBÁCZ middle-school student. 3. - A. BORBOLA university student. 4. - The group of the participant of the reception in the office of Prof. Dr. M. KEDVES. From left to right: V. SIPOS, Prof. Dr. C. ALVAREZ RAMIS, M. MADARÁSZ, and Prof. Dr. M. KEDVES. 5. - The group of participants of the reception in the Laboratory. From left to right: K. PRISKIN, A. BORBOLA, M. KEDVES, C. ALVAREZ RAMIS, J. SASHALMI, A. SZÉCSÉNYI, M. MADARÁSZ.
The pictures were taken by Dr. É. SIPOS-KEDVES.

Responsible for publication: M. KEDVES
Responsible editors: A. BORBOLA and K. PRISKIN
Cover by J. SASHALMI
Set in New Times 10/11 point
Juhász Nyomda, Szeged